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North Shore Water Supply Protection Study

Beverly, Essex, Hamilton, Manchester, Wenham

This project was funded through a Strategic Planning Grant awarded by the Executive Office of Communities and Development

MAPC
Metropolitan Area Planning Council
110 Tremont Street
Boston, MA 02108

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NORTH SHORE WATER RESOURCES STUDY

JUNE, 1988

METROPOLITAN AREA PLANNING COUNCIL
BOSTON, MASSACHUSETTS

This project was funded through a Stategic Planning Grant
by the Executive Office of Communities and Development

ABOUT THIS REPORT

This report was prepared by the staff of the Metropolitan Area Planning Council under the supervision of the Executive Director. The Metropolitan Area Planning Council is the officially designated regional planning agency for 101 cites and towns in the Boston metropolitan area. The Council offers technical assistance to its member communities in the areas of land use, housing, environmental quality, energy, transportation, and economic development.

This project has been financed with funds from the Executive Office of Communities and Development under a strategic planning grant. The contents do not necessarily reflect the views and policies of EOCD, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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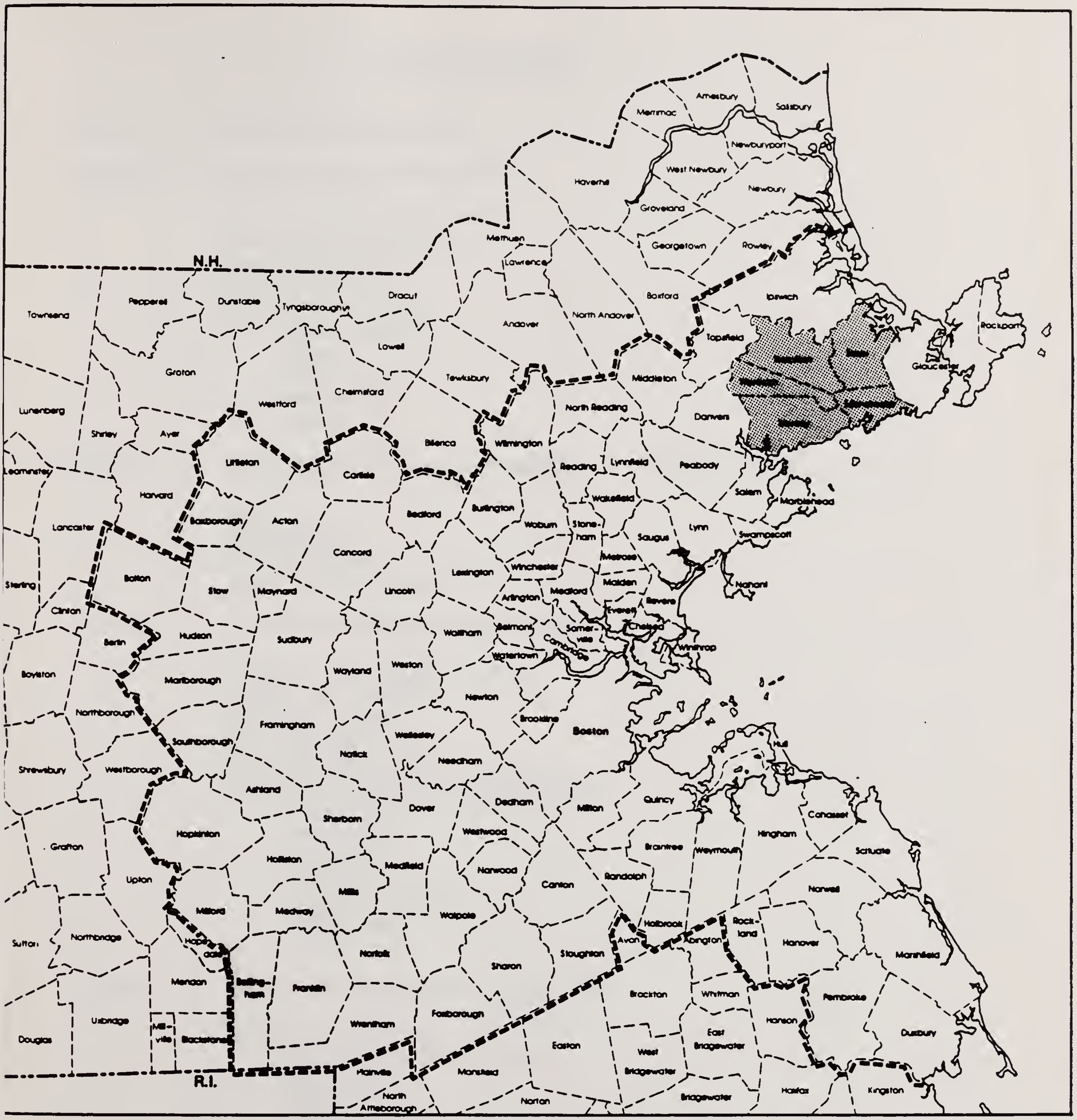

MAPC

Metropolitan Area Planning Council

North Shore Water Supply Protection Study Area

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2 Intercommunity Water Resources
3 Land Use
4 Potential Sources of Contamination
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CHAPTER 1

BACKGROUND AND SUMMARY

In 1986, Beverly, Essex, Hamilton, Manchester and Wenham formed the Intercommunity Water Resources Committee to enable the five communities to coordinate planning and management of their water resources. First on the Committee's agenda was the protection of the quality of drinking water sources in the five communities. In 1987, the Committee secured a Strategic Planning grant from the Executive Office of Communities and Development to prepare a regional water supply protection plan. The Committee engaged the services of the Metropolitan Area Planning Council (MAPC) to develop the plan. Between January and June, 1988, MAPC met monthly with the Committee, and the study was completed in July, 1988. Following submission of the study to the Committee, it was planned that the Committee would coordinate efforts to implement the plan's recommendations in each community.

The overall methodology of the study included the following steps:

- inventory the water resources of the communities and identify areas of particular significance to the quantity and quality of the water supply;
- inventory existing land uses and potential sources of contamination in the study area, and assess their potential threat to the quality of the water supply;
- analyze the zoning of undeveloped land within the study area and determine the extent to which new permitted land uses could affect the water supply in the future;
- identify and evaluate existing local, state, and federal water resources protection measures; and
- recommend additional water supply protection measures to mitigate the potential land use and zoning impacts identified in the study and insure the long term quality of drinking water sources.

All the findings and recommendations were reviewed by the Intercommunity Water Resources Committee, which met through the course of the study and provided valuable information and guidance.

The water supply systems in the communities of Beverly, Essex, Hamilton, Manchester, Salem and Wenham supply water to approximately 92,598 people. By the year 2020, the population served will be about 95,020. Individually, these communities meet current average day demands, but often fall short of peak summer needs and must buy water from other towns or use emergency sources during such shortages. Without wise management of the region's water resources, this situation will only worsen as the service population increases.

Protection of the water supply sources is vitally important to the communities given that all drinking water comes from local sources, and there are few practical alternative supply sources available to the communities. Other towns in the region have experienced contamination and supply shortages, and the Massachusetts Water Resources Authority cannot be considered an alternative. The ability of these communities to remain self-sufficient in water supply may depend upon how the communities collectively manage existing and future development in their water supply aquifers and watersheds.

Land uses within the water supply area can affect both water quality and water quantity through physical alteration of the environment which changes drainage patterns and rates of runoff and recharge, and through discharge of contaminants to surface or groundwater. Developed land uses in the study area have increased in the last thirty years by 102%. Associated with developed land uses are a number of potential contamination sources. Most of this report centers on the identification of potential sources of contamination, and measures which the communities can take to safeguard against loss of water supplies.

This report includes an investigation of the potential sources of contamination in the areas which overlay aquifers and in watershed areas for reservoirs and lakes utilized as municipal water supplies. This is the area referred to as the North Shore Water Study Area. The potential sources of contamination investigated include: underground storage tanks, wastewater, road salt, leachate, hazardous waste, pesticides and mining. In addition, this study examines zoning and other local regulations in the study area and has identified areas requiring additional protection to insure the long term quality of the water resources.

Through an analysis of this information, a set of recommendations was developed to augment and strenghten local policies and regulations to manage activities within the water supply areas. The major elements of these recommendations are:

- zoning amendments to establish Water Supply Protection Districts over the aquifers and watersheds which supply the communities with potable water;
- adoption of underground storage tank bylaws, which would strengthen existing regulations of the location, installation, and maintenance of underground storage tanks and would extend to chemical storage tanks as well as fuel storage tanks;
- adoption of hazardous materials bylaws, which would regulate the use and storage of hazardous materials;
- adoption of earth removal regulations requiring restrictions on depth of excavation above seasonal high water table and associated uses in the mining pits;
- amendments to or adoption of Board Health Regulations to strengthen requirements for septic systems; and

- amendments to subdivision regulations to require review and mitigation of potential groundwater impacts.

Implementation of the recommended program will require the cooperation and support of several local boards on an intra- and intercommunity basis, as well as town meeting and city council support for new or amended bylaws. An important element for successful implementation will be public education. The Intercommunity Water Study Committee may assist in these efforts, which may include public meetings and presentations, as well as development of brochures or other educational materials. Increasing public awareness of water supply protection will be as important as modifying local regulations in meeting the goals of the water supply protection program.

In order to strengthen the role of the Intercommunity Water Resources Committee, the study recommends the adoption of a Memorandum of Understanding by each of the communities. The MOU would define the responsibilities of the Committee, and formalize its role in coordinating the management and protection of the region's water resources.

In the chapters that follow, background information, data, analysis, and the recommended plan are presented in detail. Through the implementation of the study's proposed recommendations, the communities of Beverly, Essex, Hamilton, Manchester and Wenham may continue to move forward in the development of a comprehensive water supply protection program.

CHAPTER 2

WATER SUPPLY SYSTEM PROFILE

WATER USE AND CONSUMPTION

The water departments of Beverly/Salem, Essex, Hamilton, Manchester and Wenham supply water to 98% of the population in those communities or an estimated 92,598 persons (see Table 2-1). Approximately half (50%) of the water is used for residential consumption; commercial and industrial consumption comprise 10% and 12% of water comsumption respectively; unaccounted-for consumption comprises 28% of water use (see Table 2-2).

Table 2-1
Service Population

Town	1986 Est. Population	% Service Population	# Served
Beverly/Salem	75,030	100%	75,030
Essex	2,960	70	2,072
Hamilton	7,140	90	6,426
Manchester	5,260	100	5,260
Wenham	3,810	100	3,810
TOTAL	94,200	98%	92,598

Source: Federal Census

Table 2-2
Percentage Distribution of Water Use

Town	Residential	Commercial	Industrial	Agriculture	Other	Unaccounted
Bev/Salem	44	12	12	0	0	32
Essex	47	42	3	2	4	2
Hamilton	83	2	0	2	2	11
Manchester	72	5	0	0	11	12
Wenham	82	2	0	0	2	14
TOTAL*	50	11	10	0	1	28

* Based on weighted averages
Source: DEQE 1986 Water Supply Data

The population of this North Shore area (including the City of Salem) is now approximately 94,200. Population projections made by MAPC and DEM show populations increasing slightly over the next 30 to 40 years to about 96,000 (see Table 2-3). At the same time, the North Shore service population is also expected to increase. Hamilton's water department expects to serve 100% of its population by the year 2020, and Essex expects to increase its service population from 70% to 94%. According to MAPC projections, this would raise the overall service population from 92,598 in 1987 to an estimated 95,020 in 2020 (see Table 2-4).

Table 2-3
Population Projections Comparison MAPC to DEM

Town	1990 MAPC	1990 DEM	2000 MAPC	2000 DEM	2010 MAPC	2010 DEM
Beverly/Salem	77,400	76,366	77,460	76,400	76,700	75,928
Essex	3,000	3,060	3,000	3,150	3,000	3,200
Hamilton	7,000	7,305	7,000	7,517	7,000	7,650
Manchester	5,400	5,478	5,400	5,467	5,400	5,435
Wenham	3,900	3,873	3,900	4,150	3,900	4,250
TOTAL	96,700	96,082	96,760	96,684	96,000	96,463

Table 2-4
2020 Service Population Projections

Town	1986 Census	1986 % Served	1986 Service Population	2020 Projected Population	2020 % Served	2020 Service Population
Beverly/Salem	75,030	100	75,030	75,900	100	75,900
Essex	2,960	70	2,072	3,000	94	2,820
Hamilton	7,140	90	6,426	7,000	100	7,000
Manchester	5,260	100	5,260	5,400	100	5,400
Wenham	3,810	100	3,810	3,900	100	3,900
TOTAL	94,200	98%	92,598	95,200	99%	95,020

Source: Federal Census Data

According to water supply data collected by DEQE, current levels of water consumption for the six communities averaged 12.02 mgd in 1987 with a maximum day demand of 21.10 mg (see Tables 2-5 & 2-6 and Figure 2-1). Projected average day demand for the year 2020 is 14.80 mgd with a maximum day demand of 23.67 mgd (see Tables 2-7 & 2-8 and Figure 2-2). However, the projected water demands have already been exceeded by current use in a number of the communities (compare 1990 projections with 1987 consumption figures).

Figure 2-1

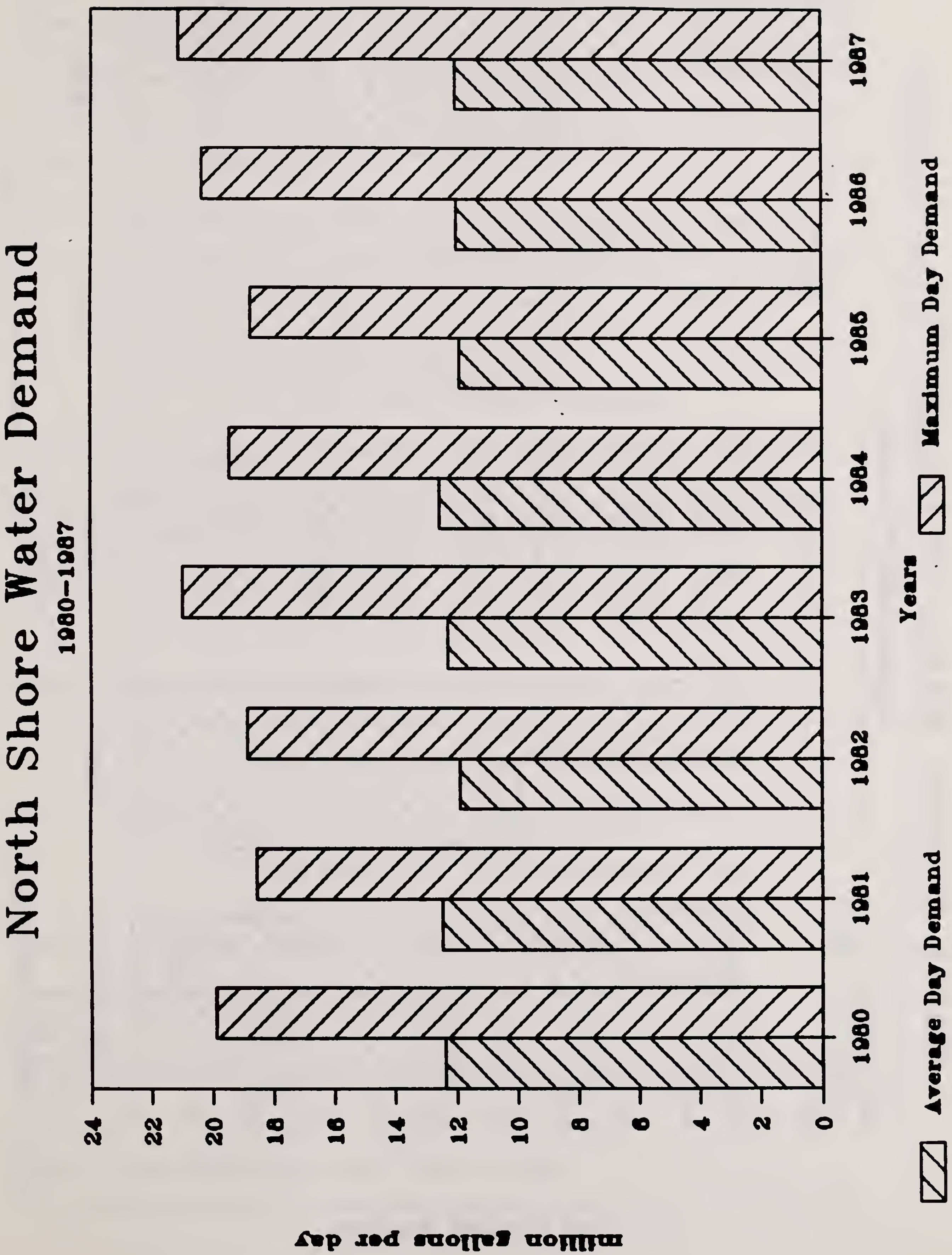

North Shore Water Demand
1980–1987
million gallons per day
0
2
4
6
8
10
12
14
16
18
20
22
24
1980
1981
1982
1983
1984
1985
1986
1987
Years
Average Day Demand
Maximum Day Demand

Figure 2-2

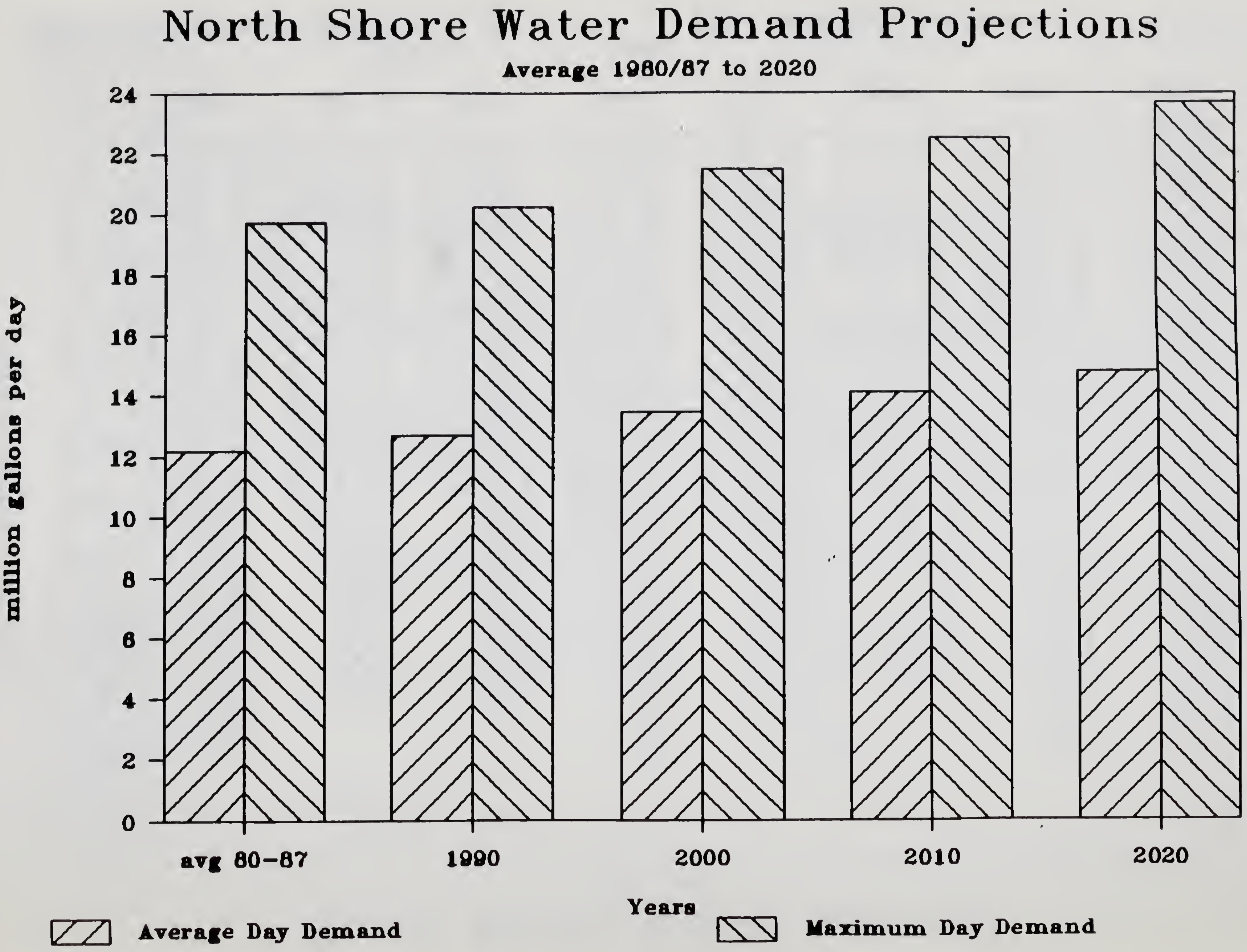

North Shore Water Demand Projections
Average 1980/87 to 2020
million gallons per day
24
22
20
18
16
14
12
10
8
6
4
2
0
avg 80-87
1990
2000
2010
2020
Years
Average Day Demand
Maximum Day Demand

Table 2-5
Public Water Supply-Average Day Demand (mgd)

Town	1980	1981	1982	1983	1984	1985	1986	1987
Beverly/Salem	10.30	10.24	9.66	9.97	10.44	9.77	9.81	9.71
Essex	0.26	0.28	0.25	0.19	0.19	0.18	0.18	0.22
Hamilton	0.77	0.95	0.98	1.00	0.91	0.92	0.97	0.96
Manchester	0.73	0.70	0.73	0.76	0.70	0.74	0.74	0.79
Wenham	0.29	0.29	0.25	0.34	0.30	0.26	0.28	0.34
TOTAL	12.35	12.46	11.87	12.26	12.54	11.87	11.98	12.02

Source: DEQE Water Supply Data

Table 2-6
Public Water Supply-Maximum Day Demand

Town	1980	1981	1982	1983	1984	1985	1986	1987
Beverly/Salem	15.91	13.91	13.35	16.59	15.26	14.55	16.16	15.67
Essex	0.54	0.62	0.74	0.40	0.32	0.41	0.31	0.62
Hamilton	1.36	1.59	1.86	1.29	1.64	1.43	1.45	1.70
Manchester	1.27	1.55	2.08	1.66	1.41	1.62	1.62	1.94
Wenham	0.81	0.86	0.81	1.03	0.81	0.72	0.72	1.17
TOTAL	19.89	18.53	18.84	20.97	19.44	18.73	20.26	21.10

Source: DEQE Water Supply Data

Table 2-7
1990-2020 Average Day Demand Projections (in mgd)

Town	1980-87 6 Year Average	1990	2000	2010	2020
Beverly/Salem	9.99	10.52	11.06	11.55	12.12
Essex	0.22	0.23	0.26	0.30	0.35
Hamilton	0.93	0.91	1.06	1.11	1.16
Manchester	0.74	0.72	0.76	0.79	0.83
Wenham	0.29	0.30	0.31	0.33	0.34
TOTAL	12.17	12.68	13.45	14.08	14.80

Source: DEM Ipswich River Basin Study, Volume I

Table 2-8
1990-2020 Maximum Day Demand Projections (in mgd)

Town	1980-87 6 Year Average	1990	2000	2010	2020
Beverly/Salem	15.18	15.75	16.56	17.29	18.15
Essex	0.51	0.51	0.58	0.67	0.78
Hamilton	1.54	1.51	1.76	1.84	1.93
Manchester	1.64	1.58	1.66	1.73	1.82
Wenham	0.87	0.87	0.90	0.96	0.99
TOTALS	19.74	20.22	21.46	22.49	23.67

Source: DEM Ipswich River Basin Study, Volume I

WATER SUPPLY SOURCES

Beverly/Salem relies 100% on surface water; Essex, Hamilton and Wenham rely solely on groundwater supplies; and Manchester uses a combination of surface and groundwater sources (see Table 2-9). The water sources in the North Shore study area include five surface water supplies and eleven groundwater supplies. Ten of these sources are located in the Ipswich River drainage basin and the remaining six sources are in the North Coastal drainage area (see Table 2-10). Although several communities in the study area are investigating alternative water supplies, no new sources will be available in the immediate future.

Table 2-9
Public Water Supply-Type of Water Supply - 1985

Town	Avg. Day Demand (mgd)	% Surface Water Use	Surface Water Use (mgd)	% Ground Water Use	Groundwater Use (mgd)
Beverly/Salem	9.77	100%	9.77	-0-	-0-
Essex	0.18	-0-	-0-	100%	0.18
Hamilton	0.92	-0-	-0-	100%	0.92
Manchester	0.74	43%	0.32	57%	0.42
Wenham	0.26	-0-	-0-	100%	0.26
TOTAL	11.87	85%	10.09	15%	1.78

Source: DEM Ipswich River Basin Study, Volume I

Table 2-10
Public Water Supply Sites and Locations

Water Supply Agency	Source	1985 Source Status	Basin	Pump Capacity (mgd)
Salem and Beverly Water Supply Board	Ipswich River	Seasonal Withdrawals	Ipswich	25.00 to Putnamville & to Wenham Lake
	Wenham Lake	Used All Year	Ipswich	25.00
	Putnamville Reservoir	Seasonal Withdrawals	Ipswich	25.00 up 12.00 back
	Longham Reservoir	Seasonal Withdrawals	Ipswich	13.00+
Essex DPW Water Dept.	Harry Homan's Well #2	Used All Year	N. Coastal	0.65
	Cent. Grove Well #3	Used May-October	N. Coastal	0.30
	Harry Homan's Well #1	Used April-May	N. Coastal	0.30
Hamilton DPW Water Dept.	Idlewood Well	Used All Year	Ipswich	0.86
	Caisson Well	Used All Year	Ipswich	0.86
	School St. Well	Used April-May	Ipswich	0.28
	Patton Well	Used All Year	Ipswich	0.28
Manchester Water Dept.	Gravelly Pond	Used All Year	N. Coastal	2.00
	Lincoln Well	Used All Year	N. Coastal	0.76
	Round Pond Well	Emergency	N. Coastal	0.40
Wenham Water Dept.	Pleasant Pond Well #1	Used All Year	Ipswich	0.40
	Pleasant Pond Well #2	Used May-Sept.	Ipswich	1.00

Source: DEM Ipswich River Basin Study, Volume I

EMERGENCY SOURCES

None of the communities in the North Shore study area have adequate emergency sources of water within their own borders. For the most part, the communities rely on their neighbors' primary supplies when they cannot meet peak demands. Beverly has emergency arrangements with Wenham; Essex interconnects with Hamilton and Gloucester; Hamilton relies on Wenham, Essex and Ipswich; and Wenham has arrangements with Hamilton and Beverly. Manchester relies on poor quality water from Round Pond well in Hamilton to replenish Gravelly Pond in emergencies.

WATER QUALITY

Water quality concerns center around salt contamination, high iron and manganese content, increasing nitrate infiltration, and the threat of potential fuel or chemical contamination. For the most part, supplies in the study area receive varied but minimal treatments, mostly comprising floridation, some chlorination and some sedimentation treatments. Beverly/Salem and Essex benefit by water treatment plants.

COMMUNITY PROFILES

The remainder of this chapter discusses each of the five North Shore communities in more detail.

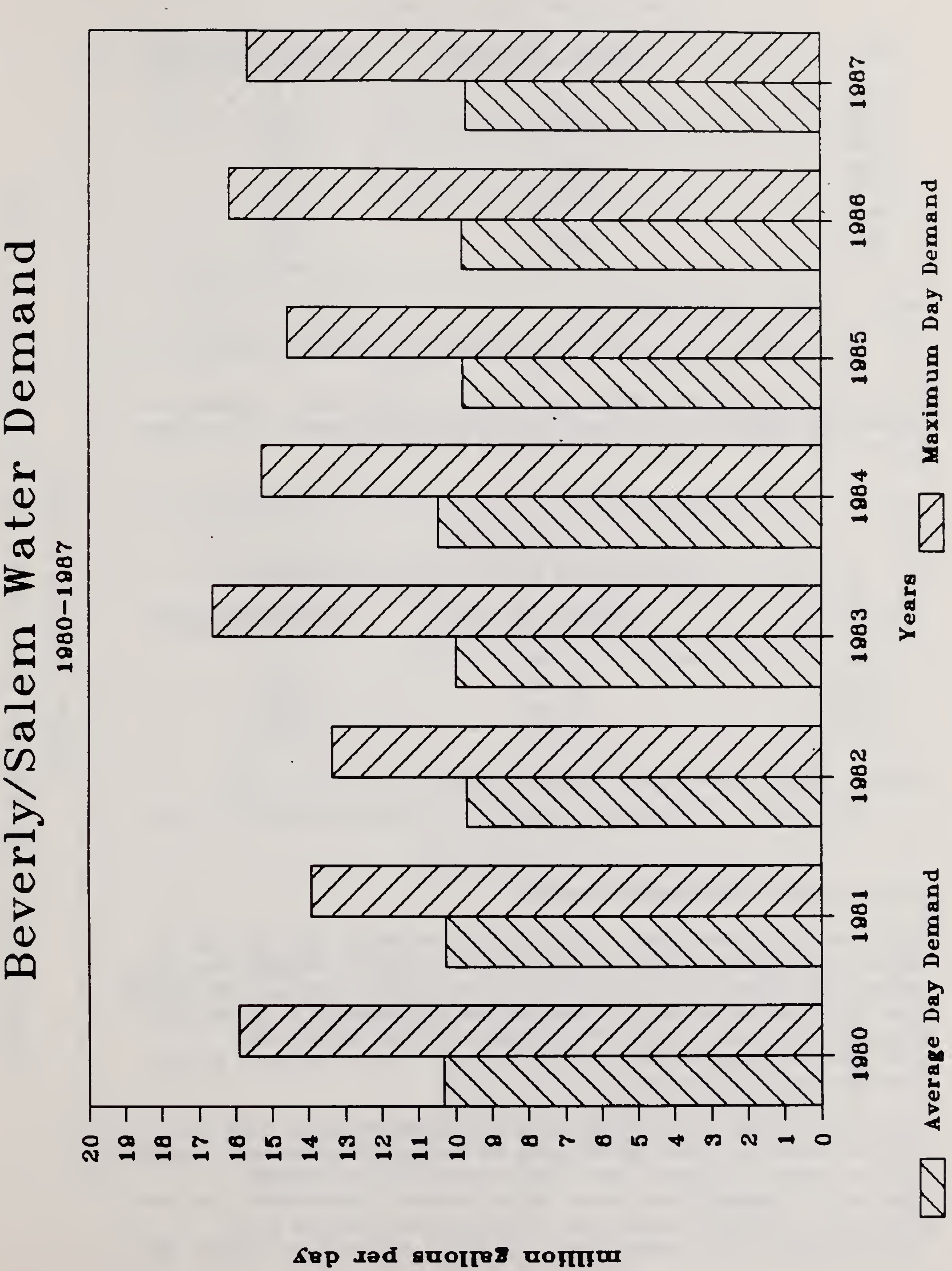
BEVERLY/SALEM WATER USE AND CONSUMPTION

The Salem and Beverly Water Supply Board provides water to a service population of 75,030 within the cities of Salem and Beverly. The Water Supply Board manages the sources and treatment of the water that it provides to the two communities on a regular basis, with each city separately managing the distribution system that provides water to its individual users. Beverly services all of the city's 36,980 residents and Salem services all of the city's 38,050 residents. Water use falls into the following categories:

Residential	44%
Commercial	12%
Industrial	12%
Agricultural	0%
Other	0%
Unaccounted for	32%
Total	100%

Over the last five years, average day demand for Beverly/Salem fluctuated between 9.66 million gallons per day (mgd) and 10.44 mgd while maximum day demand fluctuated between 13.35 mgd and 16.59 mgd. Peak demand on water supply was reached in 1983. (See Table 2-11 and Figure 2-3)

Figure 2-3


Beverly/Salem Water Demand
1980-1987
million gallons per day
0
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1984
1985
1986
1987
Years
Average Day Demand
Maximum Day Demand

Table 2-11
Beverly/Salem Historic Water use

Year	Average Day (mgd)	Maximum Day (mgd)
1987	9.71	15.67
1986	9.81	16.16
1985	9.77	14.55
1984	10.44	15.26
1983	9.97	16.59
1982	9.66	13.35
1981	10.24	13.91
1980	10.30	15.91

Source: DEQE Water Supply Data

Projections for future demand (made by the Water Board) estimate an average day demand of 12.12 mgd and maximum day demand of 18.15 mgd by the year 2020. (See Table 2-12 and Figure 2-4).

Table 2-12
Beverly/Salem Future Demand Projection

Year	Average Day (mgd)	Maximum Day (mgd)
1990	10.52	15.75
2000	11.06	16.56
2010	11.55	17.29
2020	12.12	18.15

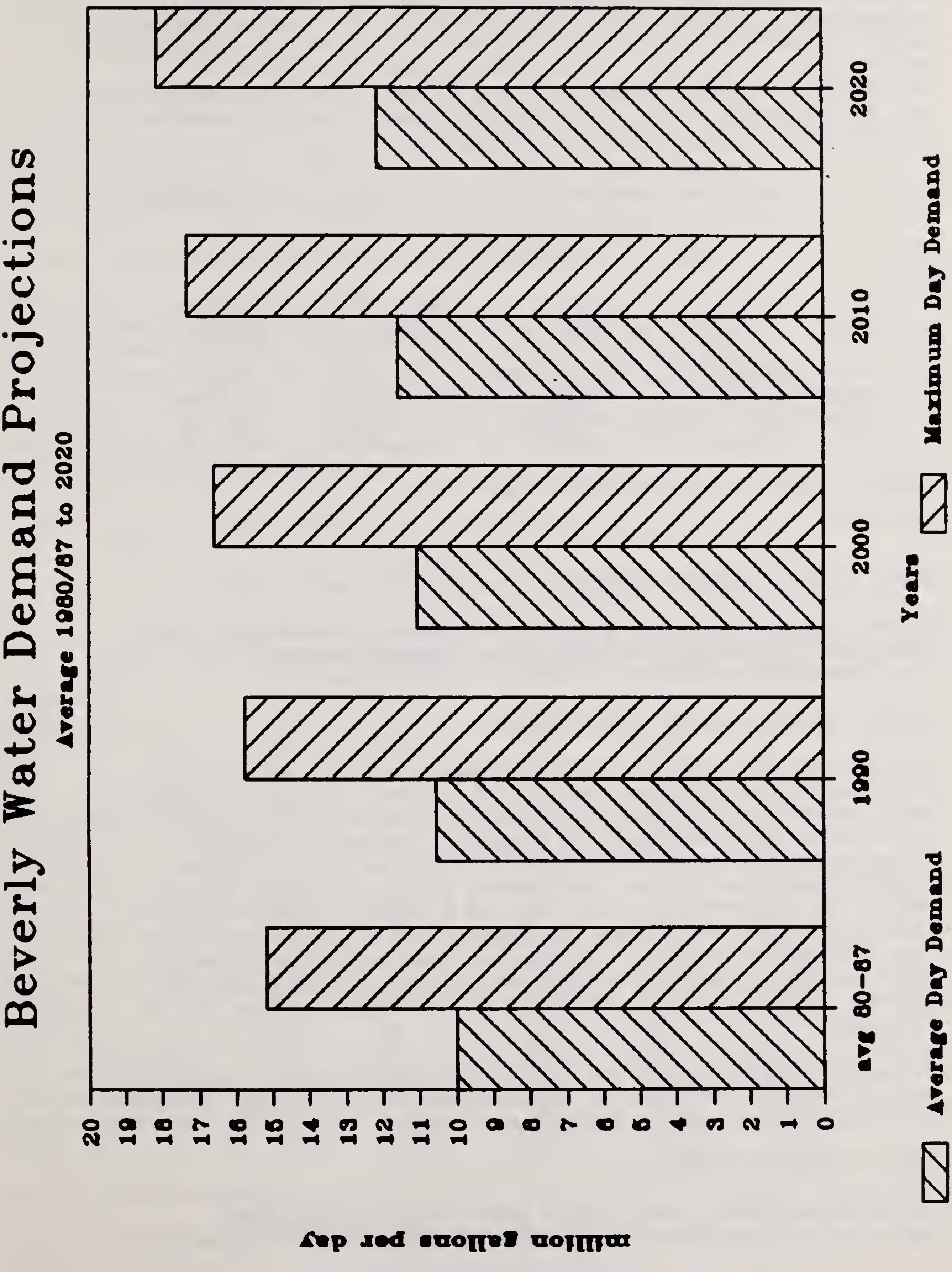
Souce: DEM Division Water Resources Data

BEVERLY/SALEM WATER SUPPLY SOURCES

The Salem and Beverly Water Supply Board relies on four sources of surface water for supply: 1) the Ipswich River, 2) Wenham Lake, 3) Putnamville Reservoir, and 4) Longham Reservoir. Wenham Lake is used year-round while the other three sources are seasonal. In addition, Putnamville and Longham Reservoirs are used for storage and distribution; however, all service to the cities originates at the treatment plant on Wenham Lake.

The system allows for the pumping and transfer of water from the Ipswich River to either Wenham Lake or Putnamville Reservoir. Water is also pumped to Wenham Lake from Putnamville and Longham Reservoirs. Wenham Lake serves as the central containment site where all water is pumped through the treatment plant before it is redistributed to the communities. In 1987, 831 million gallons (mg)

Figure 2-4


Beverly Water Demand Projections
Average 1980/87 to 2020
million gallons per day
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
avg 80-87
1990
2000
2010
2020
Years
Average Day Demand
Maximum Day Demand

of water were pumped from the Ipswich River to Putnamville Reservoir; 981 mg were pumped from Longham Reservoir to Wenham Lake; and 905 mg were pumped from Putnamville Reservoir to Wenham Lake.

Longham Reservoir has the largest of the three watershed areas, encompassing 3.42 square miles, but holds only 50 million gallons of water. Putnamville Reservoir has the smallest watershed area at .85 square miles, but has the largest storage capacity measured at 2.3 billion gallons (bg). Wenham Lake's watershed is 2.44 square miles and the lake holds 1.2 bg. Total storage capacity in the system is 3.55 billion gallons of water (see Table 2-13).

Table 2-13
Beverly/Salem Water Supply Sources

Source	Type	Watershed Area	Storage Capacity
Ipswich River	diversion	NA	NA
Longham Reservoir	manmade	3.42 sq.mi.	.05 bg
Putnamville Reservoir	manmade	.85 sq.mi.	2.3 bg
Wenham Lake	natural	2.44 sq.mi.	1.2 bg

Source: Salem and Beverly Water Supply Board

BEVERLY/SALEM EMERGENCY SOURCES

According to the Wenham Water Department, the cities of Beverly and Salem have an emergency connection from Wenham's treatment plant. No other emergency sources are available to the cities.

BEVERLY/SALEM POTENTIAL FUTURE SOURCES

Studies have shown that no viable groundwater sources exist in the area; however, supplemental surface water sources have been located. The Salem and Beverly Water Supply Board owns a parcel of land set aside for the proposed Topsfield Reservoir, located in the deep valley north of Putnamville Reservoir. This reservoir would have a storage capacity of 1.8 bg. Development of this reservoir would require the construction of two dams and a pumping system to tie the Ipswich River and the Putnamville Reservoir to it (requiring a three year construction period). The drainage area would be very small, approximately .60 sq. mi., so the reservoir would be used only for storage. However, at this time there are no immediate plans for its development.

The water treatment plant, rebuilt in 1978, treats 25 mgd. The plant could be expanded to allow for the treatment of up to 32 mgd if other water sources are added to the system.

BEVERLY/SALEM WATER QUALITY

The Salem and Beverly Water Supply Board maintains extensive monitoring of its system. The overall water quality of its sources meets the state standards; however, some potential sources of pollution have been discovered. An area located west of Wenham Lake, within the watershed, is drained by Airport Brook. Adjacent to the brook is the Vitale Fly Ash Dump which is suspected of being a direct source of pollution to the watershed. High sodium levels and trace metals have been measured in the delta of Airport Brook, where the waterway enters Wenham Lake.

Water quality problems with the Ipswich River have also been identified, particularly those caused by nearby fuel spills. This raises a major concern given that the Ipswich River provides nearly 50% of the Water Board's water supply. No threats to the water quality of Putnamville and Longham Reservoirs have been identified, though sodium content is a seasonal concern for Longham Reservoir.

BEVERLY/SALEM WATER TREATMENT

Beverly and Salem's drinking water receives a variety of treatments, including sedimentation and filtration, at the Salem and Beverly water treatment facility on Wenham Lake. In 1987, the following chemicals were applied during water treatment in the noted quantities (mg/l): Alum 26.14; Lime 8.75; Calgon 0.96; Carbon 3.24; Chlorine 2.76; and Floride 0.89. In addition, the Putnamville Reservoir is aerated. Table 2-14 summarizes the results of 1987 water quality tests for the Water Supply Board.

Table 2-14
Beverly/Salem Drinking Water Quality

	Ipswich River	Longham Reservoir	Putnamville Reservoir	Wenham Lake	Finished Water
Turbidity	0.5	0.4	0.4	0.3	0.3
Sediment	0	0	0	0	0
Color	70	70	30	25	10
Odor	0	0	0	0	0
pH	6.6	6.5	6.6	6.6	6.9
Alkalinity-Total	37	16	13	18	21
Hardness	53	29	33	36	55
Calcium	16	7.8	9.6	10	17
Magnesium	3.2	2.1	2.1	2.7	2.9
Sodium	26	18	13	13	15
Potassium	1.9	1.0	0.9	1.0	1.0
Iron	.51	.53	.06	<.04	<.04
Manganese	.19	.04	<.03	<.03	<.03
Sulfate	12	10	16	20	32
Chloride	48	29	23	25	27
Spec. Cond. (u/cm)	228	147	131	154	202
Nitrogen (Ammonia)	0.07	0.06	<0.02	<0.02	<0.02
Nitrogen (Nitrate)	0.3	<0.1	0.1	0.3	0.3
Nitrogen (Nitrite)	0.001	0.002	0.002	<0.002	<0.002
Cooper	<.03	<.03	<.03	<.03	<.03

Source: DEQE Water Quality Data

BEVERLY DISTRIBUTION AND STORAGE

Beverly maintains 2 water storage reservoirs of 3.82 mg and 3.78 mg capacity on Brimbal Hill, and one elevated tank of 1 mg capacity on Fawley Hall Road. Total storage equals 8.60 mg.

Beverly maintains 129 miles of water main throughout the city.

ESSEX WATER USE AND CONSUMPTION

The Town of Essex supplies water to about 2,072 people, which is 70 percent of the town's population. There are 899 service connections in the system. The maximum day consumption for 1987 was 617,000 gallons with an average day consumption calculated at 215,000. Per capita usage averages 95 gallons/day (a relatively low rate of consumption). All of Essex's services are metered.

Water use falls into the following major categories:

Residential	47%
Commercial	42%
Industrial	3%
Agricultural	2%
Other	4%
Unaccounted for	2%
Total	100%

Since 1980, average day demand has fluctuated between 0.18 mgd and 0.28 mgd, with a trend towards decreased water use in recent years. Maximum day demand has fluctuated between 0.31 mgd and 0.74 mgd, with a peak demand in 1982 (see Table 2-15 and Figure 2-5).

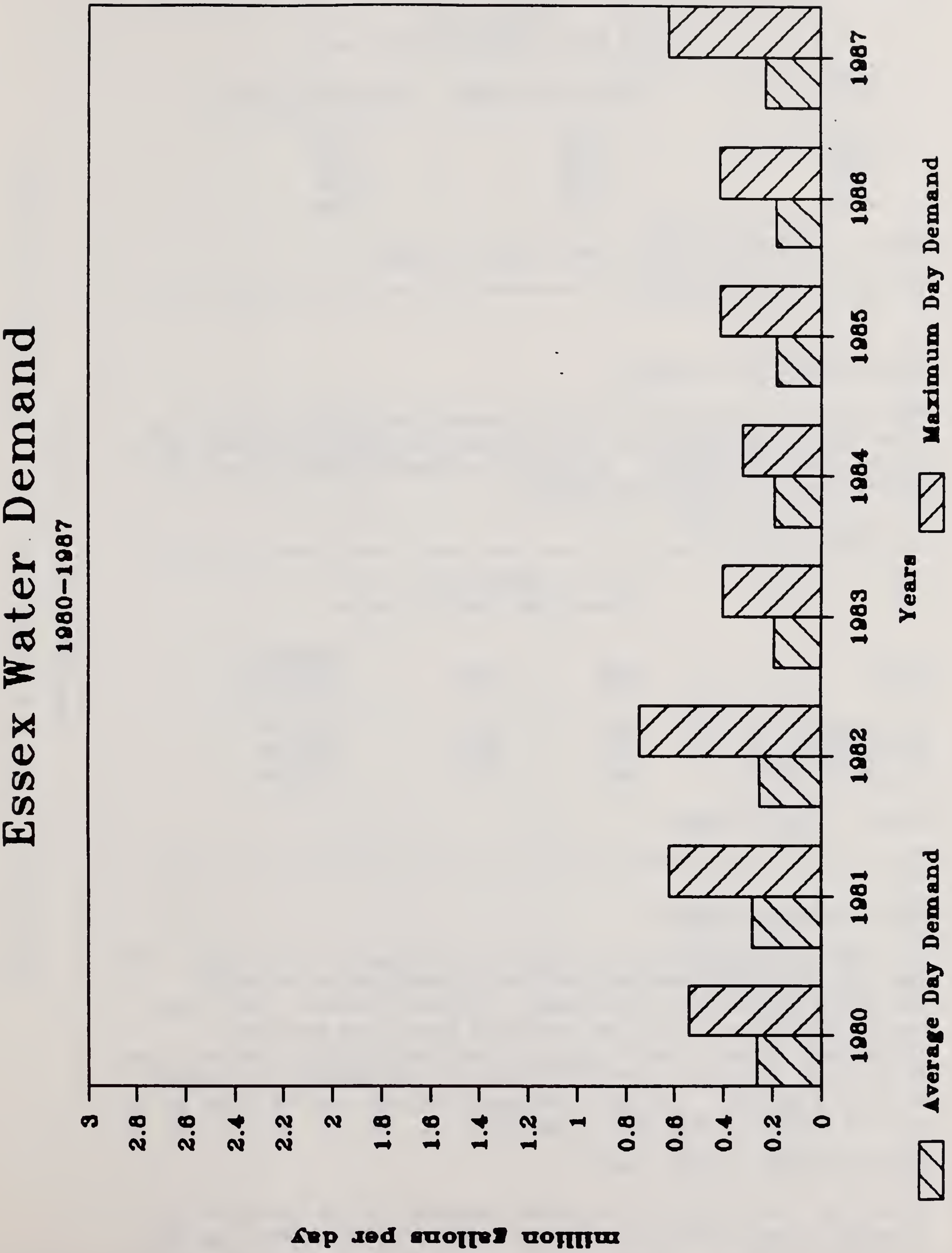
Table 2-15
Essex Historic Water Use

Year	Average Day (mgd)	Maximum Day (mgd)
1987	0.22	0.62
1986	0.18	0.31
1985	0.18	0.41
1984	0.19	0.32
1983	0.19	0.40
1982	0.25	0.74
1981	0.28	0.62
1980	0.26	0.54

Source: DEQE Water Supply Data

Projections for future water demand by the Department of Environmental Management (DEM) estimate that by the year 2020, average day demand will be 0.35 mgd and maximum day demand will be 0.78 mgd (see Table 2-16 and Figure 2-6). Note that these

Figure 2-5


Essex Water Demand
1980–1987
million gallons per day
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1980
1981
1982
1983
1984
1985
1986
1987
Years
Average Day Demand
Maximum Day Demand

projections are already exceeded for maximum day demand and that the average day demand is also very close (compare Tables 2-15 and 2-16).

Table 2-16
Essex Future Demand Projections

Year	Average Day (mgd)	Maximum Day (mgd)
1990	0.23	0.51
2000	0.26	0.58
2010	0.30	0.67
2020	0.35	0.78

Source: DEM Ipswich River Basin Study, Volume I

ESSEX WATER SUPPLY SOURCES

The town of Essex depends fully on groundwater sources. Presently, three gravel pack wells are on-line with the ability to supply up to 1.1 mgd (see Table 2-17). With major engineering alterations the supply capability could be doubled.

Table 2-17
Essex Water Supply Sources

Wells	Size	Depth	Pumping Capacity
Harry Homans #1	24"	38'6"	220 gpm
Harry Homans #2	23"	38'6"	550 gpm
Centennial Grove	48"	31'0"	330 gpm

Source: Town of Essex

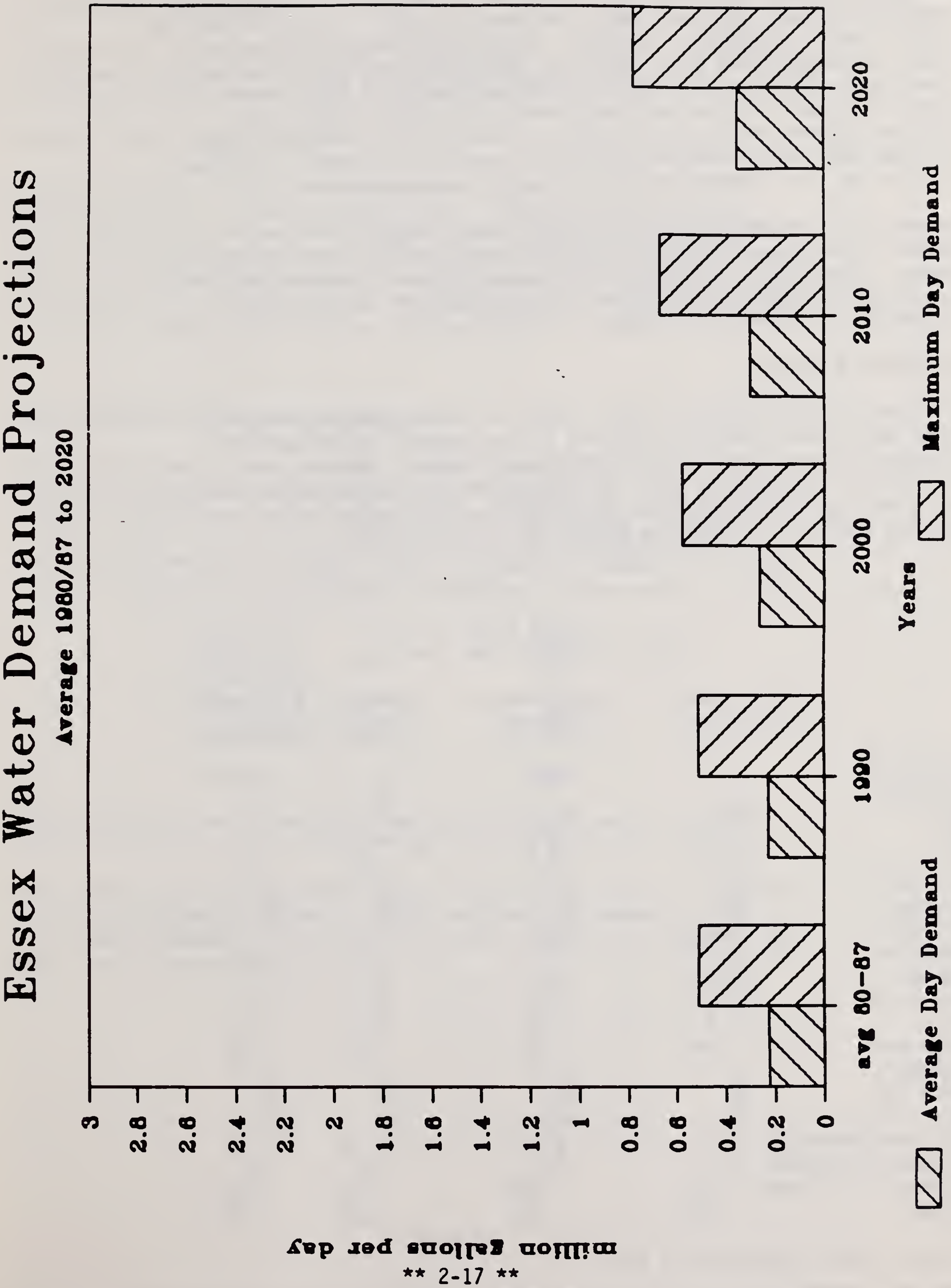
ESSEX EMERGENCY SOURCES

The town of Essex maintains an ample, well managed water supply. The town does not experience critical water shortages during which emergency water sources are needed. The town, however, does supply nearby communities with water when they experience emergency situations. Essex's water supply system interconnects with the towns of Hamilton (through a 10" x 10" pipeline) and Gloucester (through a 12" x 6" pipeline). In 1987, the town of Essex supplied about 3 million gallons to the town of Hamilton.

ESSEX POTENTIAL FUTURE SOURCES

Essex does not anticipate any water shortages in the coming years, although it does predict as much as a 25% increase in services over the next five years. However, it is realized that a back-up source

Figure 2-6


Essex Water Demand Projections
Average 1980/87 to 2020
million gallons per day
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
avg 80-87
1990
2000
2010
2020
Years
Average Day Demand
Maximum Day Demand

is necessary. At one time, Chebacco Lake was intended to serve as a back-up source; however, due to lack of easy access, this surface water source is no longer considered a viable option.

In 1985, Essex contracted Dufresne-Henry (consulting firm) to investigate other potential sources of water supply. A study, conducted between 1983 and 1987, included a number of test borings to locate viable groundwater sources. Information provided from this study, in conjunction with follow-up investigations by the Town, shows that one site (Well 16-83) could be developed for a dewatering site. This well is located approximately 200 feet north of the Centennial Grove Road Well, within the same aquifer recharge area. This new well would replace the existing well #3; however, problems with a high iron content would have to be contended with.

Another site recommended as a potential water supply is along Southern Avenue near Manchester at the north end of Great Cedar Swamp. This area requires further investigation to determine if it is a viable source of water, but in the meanwhile it should be protected to preserve the source for future use.

ESSEX WATER QUALITY

The Essex Water Treatment Plant treats all water pumped from the three wells before distributing it to the system. Water quality problems include high iron and manganese levels. However, the five-year old treatment plant is considered to function exceptionally well, and can easily meet current demand. The results of water quality analysis in 1987 are presented in Table 2-18.

Table 2-18
Essex Drinking Water Quality

	Harry Homan's Well #1	Harry Homan's Well #2	Chebacco Lake	Finished Water
Turbidity	4.8	13.1	33	0.2
Sediment	1	1	2	0
Color	200	80	116	1
Odor	0	1Dis	0	0
pH	6.5	6.1	6.3	7.6
Alkalinity	23	16	22	55
Hardness	31	27	29	29
Calcium	8.8	6.7	7.6	7.7
Magnesium	2.2	2.4	2.5	2.5
Sodium	9.8	8.3	8.1	10.
Potassium	0.9	1.0	0.9	42.
Iron	7.0	3.6	9.8	<.04
Manganese	.24	.31	.25	<.03
Sulfate	10	13	8	29
Chloride	20	14	16	16
Spec. Cond.	122	108	114	253
Nitrogen (ammonia)	0.24	0.13	0.10	0.02
Nitrogen (nitrate)	<0.1	<0.1	0.1	0.1
Nitrogen (nitrite)	.012	.007	.005	<.002
Copper	<.03	.03	<.03	.06

Source: DEQE Water Quality Data

The Town of Essex does not have any zoning in place to protect the well sites from threats of pollution. Although most of the land on which the wells are located is owned by the Town, nothing in the Town bylaws stipulates that this property remain undeveloped for water supply protection.

ESSEX WATER TREATMENT

The Essex Water Treatment Plant has the capability to treat 1.5 mgd. Treatment processes are used mostly to reduce the high levels of iron and manganese found in Essex's water sources.

ESSEX DISTRIBUTION AND STORAGE

A 225,000 gallon water storage tank is located on-site at the treatment plant. Another storage tank, located on Story Street, holds 565,000 gallons. This tank may be replaced by a newly constructed tank to be built on an adjacent piece of property. The Town is in the process of negotiating a land donation by the present landowner of the proposed site. The water supply is distributed to individual users by 14.9 miles of 8" main.

HAMILTON WATER USE AND CONSUMPTION

The town of Hamilton Department of Public Works supplies water to about 6,426 people, or 90% of the town's population. There are 2,340 service connections in the town. In 1987, the system delivered a total of 349 million gallons, with an average day demand of 0.96 million gallons per day (mgd), and a maximum day demand of 1.7 mgd. Water use in Hamilton falls into the following categories:

Residential	83%
Commercial	2%
Agricultural	2%
Municipal	2%
Unaccounted for	11%
Total	100%

In addition to the water delivered by Hamilton's wells, about 3 million gallons were purchased from the town of Essex in 1987.

Since 1980, average day demand has fluctuated between 0.77 mgd and 1.0 mgd, reaching its peak in 1983. Maximum day demand has fluctuated between 1.29 mgd and 1.86 mgd, reaching the peak in 1982 (see Table 2-19 and Figure 2-7).

Figure 2-7

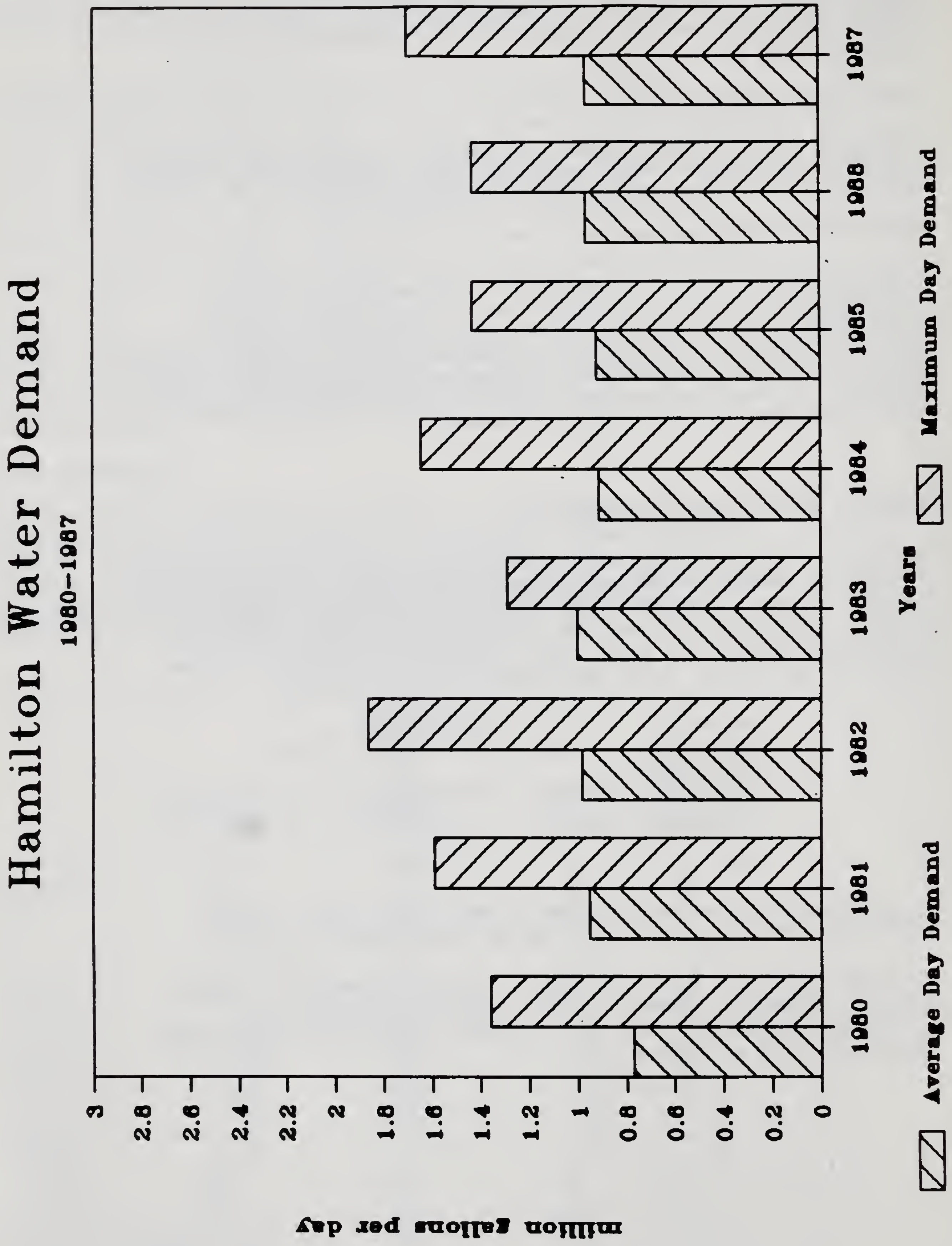

Hamilton Water Demand
1980–1987
million gallons per day
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1980
1981
1982
1983
1984
1985
1986
1987
Years
Average Day Demand
Maximum Day Demand

Table 2-19
Hamilton Historic Water Use

Year	Average Day (mgd)	Maximum Day (mgd)
1987	0.96	1.70
1986	0.92	1.45
1985	0.92	1.43
1984	0.91	1.64
1983	1.00	1.29
1982	0.98	1.86
1981	0.95	1.59
1980	0.77	1.36

Source: DEQE Water Supply Data

Projections of future demand by the Department of Environmental Management estimate that by the year 2020, average day demand will rise to 1.16 mgd, and maximum day demand will rise to 1.93 mgd (see Table 2-20 and Figure 2-8). However, these projections are already exceeded by current use. In 1987, Hamilton's water use exceeded the 1990 average day projection by 0.05 mgd and was 0.19 mgd over the 1990 maximum day demand projection. At current rates, Hamilton will far exceed the demand projections set for 2020.

Table 2-20
Hamilton Future Demand Projections

Year	Average Day (mdg)	Maximum Day (mgd)
1990	0.91	1.51
2000	1.06	1.76
2010	1.11	1.84
2020	1.16	1.93

Source: DEM Ipswich River Basin Study, Volume I

HAMILTON WATER SUPPLY SOURCES

Hamilton relies solely on groundwater as its source of public water supply. The town operates four gravel pack wells with a combined pumping capacity of 1,110 gallons per minute (see Table 2-21). Currently, the School Street well is operated on an emergency basis only, but the well should be back in regular production in 1988.

In 1987, the wells produced a total of 348.9 million gallons, as shown below. More than half of the water produced came from Idlewood Well.

Figure 2-8

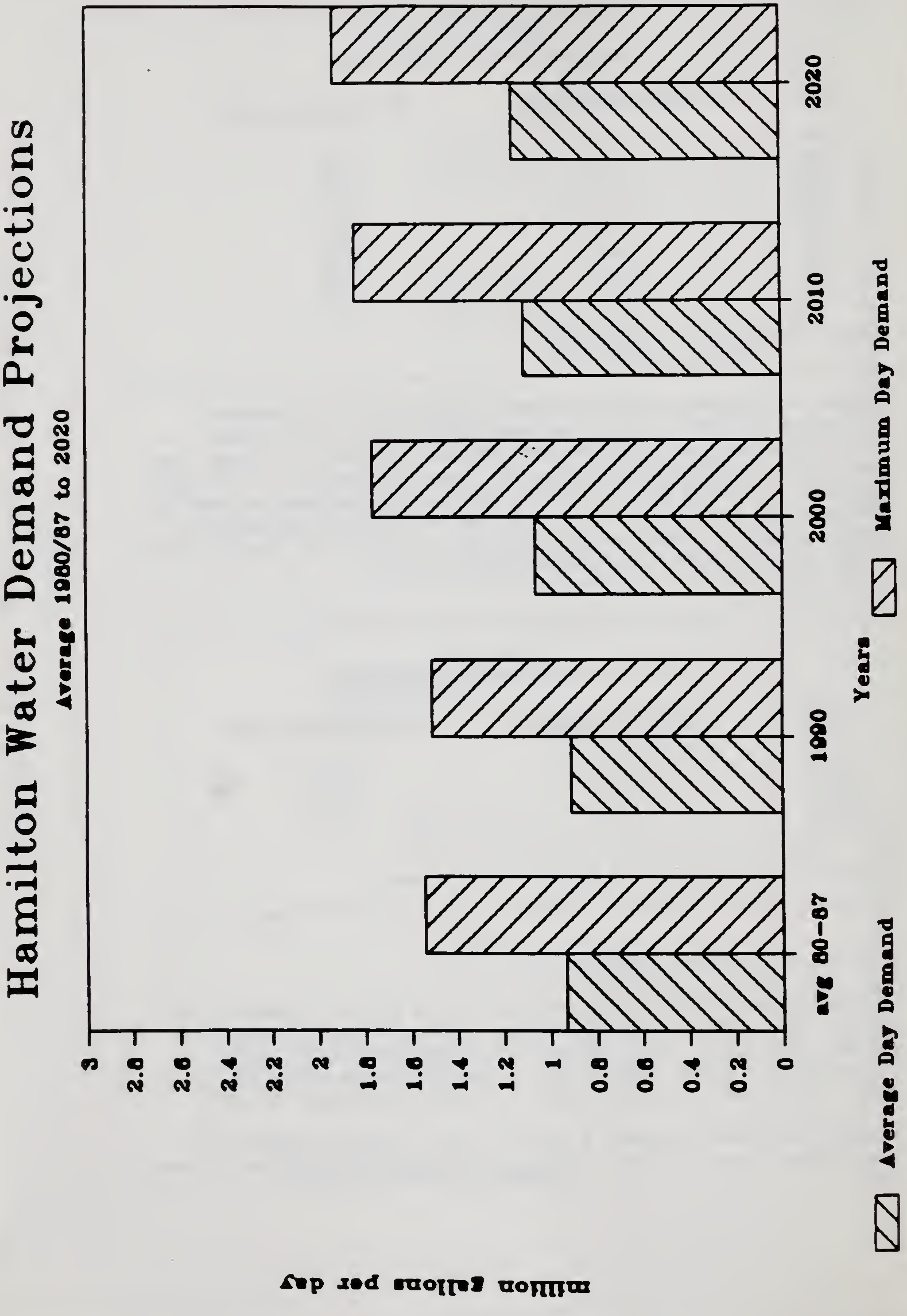

Hamilton Water Demand Projections
Average 1980/87 to 2020
million gallons per day
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
avg 80-87
1990
2000
2010
2020
Years
Average Day Demand
Maximum Day Demand

Table 2-21
Hamilton Water Supply Sources

Wells	Type	Depth	Pumping Capacity (gpm)	Year Installed	1987 Production	% Total
Caisson	Gravel pack	39'	350	1963	114.6 mg	32.8%
Idlewood	Gravel pack	48'	390	1975	185.7 mg	53.2%
Patton	Gravel pack	41'	130	1957	48.6 mg	14.0%
School St.	Gravel pack	33'	230	1952	not available	

Source: Hamilton Water Board

HAMILTON EMERGENCY SOURCES

Currently, the School Street well is being used on an emergency basis, although it will return to regular production in 1988. There are no other emergency sources within the town of Hamilton. There are interconnections with the towns of Wenham, Essex, and Ipswich. In 1987, 3 million gallons were purchased from Essex.

HAMILTON POTENTIAL FUTURE SOURCES

Two additional wells are being developed in Hamilton. The abandoned Bridge Street well is being renovated by Gordon College. This well can produce about 150,000 gallons per day. A potential new water source has been identified off of Pine Tree Drive on land owned by the Massachusetts Audubon Society. A proposal for an auxillary well at this site is currently under review.

HAMILTON WATER QUALITY

The water supplied by the Hamilton DPW meets all quality standards under the Safe Drinking Water Act. In 1987, only one source, the School Street well, exceeded the recommended sodium level, but this well was not in production at the time. The results of quality analysis in 1987 are presented Table 2-22.

Table 2-22
Hamilton Drinking Water Quality, 1987 (mgl)

Parameters	School St.	Patton	Caisson	Idlewood
Turbidity	8.0	0.8	3.7	0.6
Sediment	0	0	0	0
Color	12	5	17	0
Odor	0	0	0	0
pH	6.5	6.6	7.5	7.6
Alkalinity-total	49	49	116	118
Hardness	104	78	156	135
Calcium	28	21	46	44
Magnesium	8.2	6.1	10.0	6.2
Sodium	22	13	16	12
Potassium	2.6	1.6	2.4	1.7
Iron	0.29	<0.04	0.24	<0.04
Manganese	<0.03	0.03	0.23	0.27
Sulfate	30	21	34	34
Chloride	36	21	28	19
Spec. Cond. (u/cm)	311	214	388	323
Nitrogen (Amonia)	<0.02	<0.02	<0.02	<0.02
Nitrogen (Nitrate)	4.8	0.4	0.4	<0.1
Nitrogen (Nitrite)	0.007	<0.002	0.006	<0.002
Copper	<0.03	0.05	0.03	<0.03

Source: DEQE Water Quality Data

HAMILTON WATER TREATMENT

Hamilton's water is treated with the addition of floride. Floride treatment will be installed at the School Street well by 1988. All other sources are presently treated.

HAMILTON DISTRIBUTION AND STORAGE

The town has one water storage facility, an underground cement tank with a capacity of 850,000 gallons. Water is distributed through a network of 56.5 miles of water mains.

MANCHESTER WATER USE AND CONSUMPTION

The Manchester Water Department supplies water to about 5,260 people in Manchester. There are about 1,920 service connections and in 1987 the system delivered 289,259,000 gallons with an average day demand of 792,490 gallons per day and a maximum day demand of 1,941,724 gallons per day. Water use falls into the following categories:

Residential	72%
Agricultural	0%
Commercial	5%
Industrial	0%
Other	11%
Unaccounted-for	12%
Total	100%

Over the last eight years, average day demand has fluctuated between 0.70 and 0.79 mgd, with peak demand in 1987. Over the same time period, maximum day demand has fluctuated between 1.27 mgd and 2.08 mgd with peak demand in 1982 (see Table 2-23 and Figure 2-9). This exceeds the current system safe yield of 0.98 mgd.

Table 2-23
Manchester Historic Water Use

Year	Average Day (mgd)	Maximum Day (mgd)
1987	0.79	1.94
1986	0.74	1.62
1985	0.74	1.62
1984	0.70	1.41
1983	0.76	1.66
1982	0.73	2.08
1981	0.70	1.55
1980	0.73	1.27

Source: DEQE Water Supply Data

Projections of future demand by the Department of Environmental Management estimate that by the year 2020, average day demand will be 0.83 mgd and maximum day demand will be 1.82 mgd (see Table 2-24 and Figure 2-10). However, as one can see by comparing the data to current use in Table 2-23, the 1990 projections have already been exceeded.

Table 2-24
Manchester Future Demand Projections by DEM

Year	Average Day (mgd)	Maximum Day (mgd)
1990	0.72	1.58
2000	0.76	1.66
2010	0.79	1.73
2020	0.83	1.82

The Manchester Water Department developed its own future demand projections, and estimate that by the year 2010, average day demand

Figure 2-9

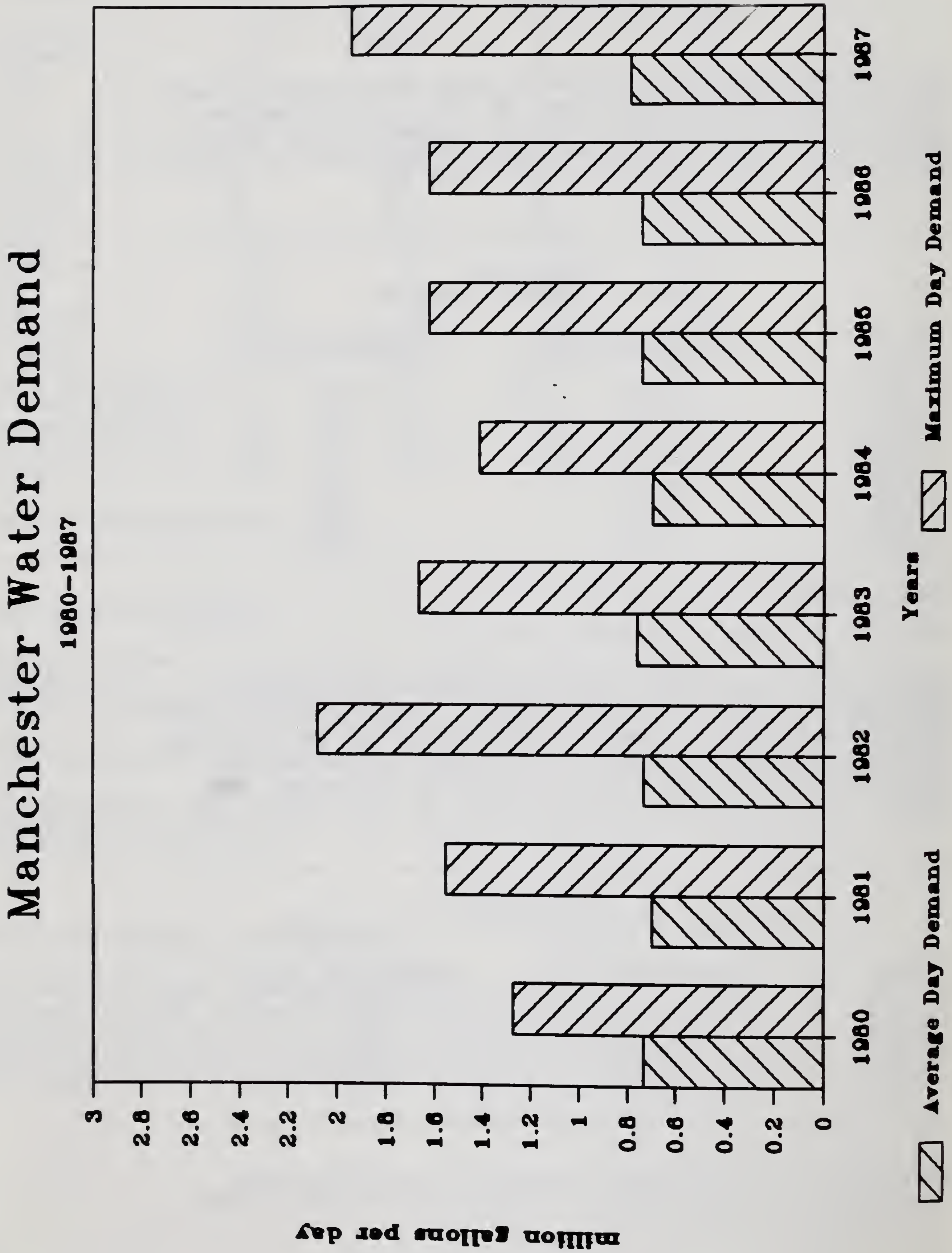
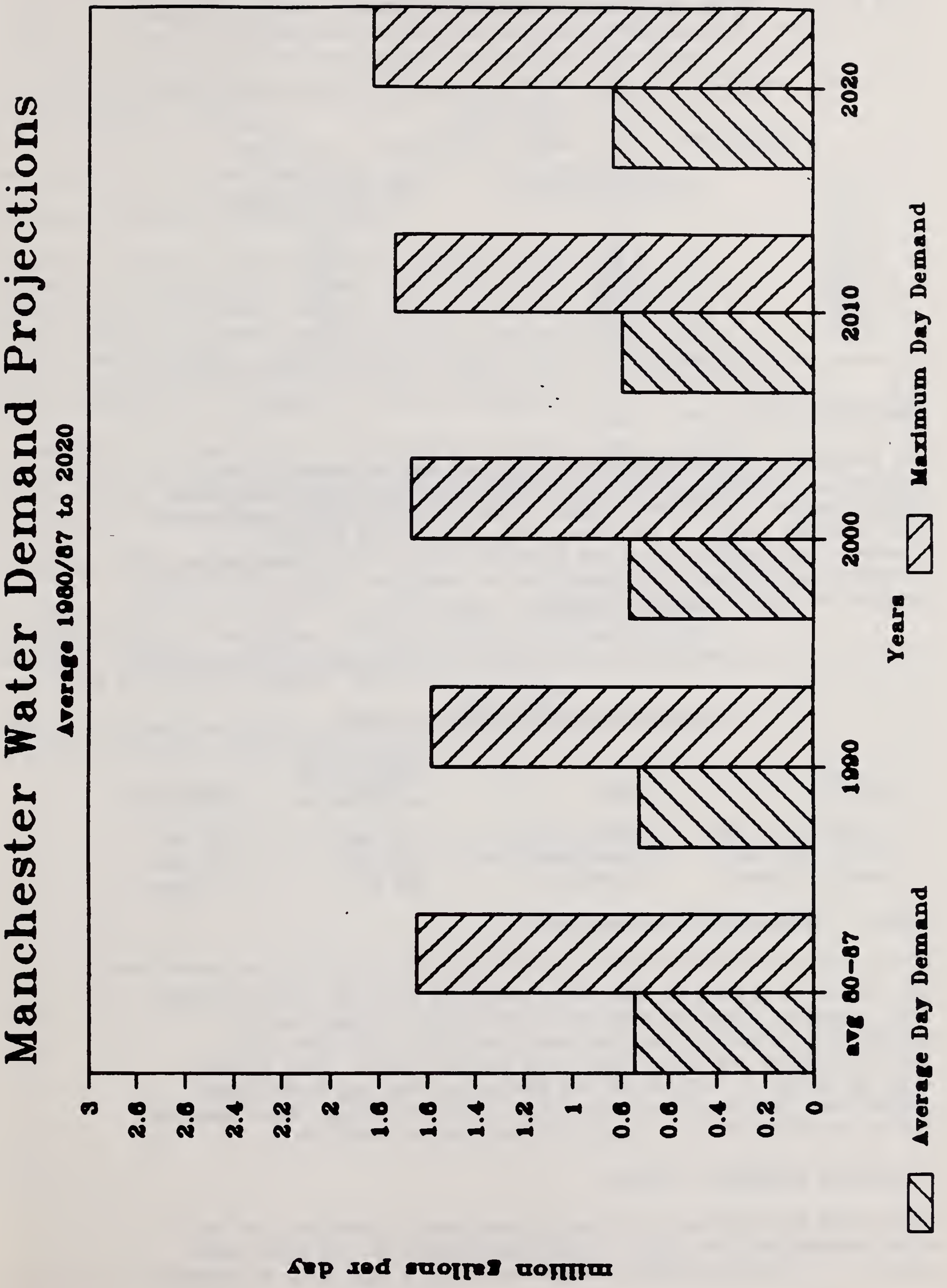

Manchester Water Demand
1980–1987
million gallons per day
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1980
1981
1982
1983
1984
1985
1986
1987
Years
Average Day Demand
Maximum Day Demand

Figure 2-10


Manchester Water Demand Projections
Average 1980/87 to 2020
million gallons per day
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
avg 80-87
1990
2000
2010
2020
Years
Average Day Demand
Maximum Day Demand

will be 1.04 mgd, while maximum day demand will be approximately 2.23 mgd (see Table 2-25). These are about 30 percent higher than the projections made by the Department of Environmental Management. Also note that the Water Department's projections place water consumption far in excess of the systems current safe yield of 0.98 mgd.

Table 2-25
Manchester Future Demand Projections by the Town

Year	Average Day (mgd)	Maximum Day (mgd)
1990	0.85	2.02
1995	0.91	2.07
2000	0.96	2.12
2005	1.00	2.17
2010	1.04	2.23

MANCHESTER WATER SUPPLY SOURCES

The Manchester Water Department relies on one surface and two groundwater sources which have a combined safe yield of 0.98 mgd. Surface water from Gravelly Pond in Hamilton is a major source of public water supply to the town, with 100 million gallons of storage. Groundwater from the Lincoln Street Well in Manchester, and a second well adjacent to Round Pond in Hamilton, comprise the other sources of water (see Table 2-26).

Table 2-26
Manchester Water Supply Sources

Source	Type	Pump/Storage Capacity	Safe Yield
Lincoln St. Well	gravel/pack	0.43 mgd	0.43 mdg
Round Pond Well	gravel/developed	0.43 mgd	0.43 mgd
Gravelly Pond	diversion	100 mg	0.118 mgd

Source: Manchester Water Department

The system is set up so that water obtained from the Lincoln Street Well is pumped directly into the distribution system, while groundwater obtained from the Round Pond Well is pumped into a settling lagoon and then flows into Gravelly Pond. From Gravelly Pond the water is treated at the Manchester Pumping Station and pumped into distribution to the town. Gravelly Pond, Round Pond and the Round Pond Well are located in the town of Hamilton.

MANCHESTER EMERGENCY SOURCES

Round Pond Well can only be used in emergency situations and only after permission from DEQE is obtained because of its poor water quality. It can be pumped twenty-four hours a day, with no apparent decrease in capacity, to raise the level in Gravelly Pond. This, however, is far from adequate to meet Manchester's growing demands and risks compromising the quality of Gravelly Pond. A comparison of the safe yield for the three sources, which is 0.98 mgd (see Table 2-26), to average and maximum day demands in 1987 (see Table 2-23), shows that though there is a small surplus for average day demand (0.19 mgd), there is a 0.96 mgd deficit for maximum day demand. By the year 2010, the deficit, according to Manchester figures in Table 2-25 would be in excess of 0.06 mgd for average day demand and 1.25 mgd for maximum day demand.

Manchester has no other emergency sources of public water.

MANCHESTER POTENTIAL FUTURE SOURCES

Manchester recently contracted with Whitman & Howard, Inc., to determine the feasibility of developing Round Pond in Hamilton as a future source of drinking water. According to the "Preliminary Report Relative to Round Pond, Manchester, Massachusetts" (July 1987), Round Pond has a potential safe yield of 1.5 million gallons per day and the water quality analysis placed water quality either within standards or "treatable to those standards".

The addition of Round Pond to the Manchester Water supply system would enable Manchester to meet maximum day demands projected through the year 2010, but would require the addition of a water treatment facility to aleviate quality concerns.

MANCHESTER WATER QUALITY

The water quality in Manchester exceeds DEQE recommendations for iron and rates high for manganese. Nitrate levels, although within standards, have been increasing in recent years and sodium levels seasonally exceed recommended levels.

Table 2-27 shows the results of water quality analysis in 1987 for Gravelly Pond and Lincoln Street Well.

Table 2-27
Manchester Drinking Water Quality in 1987 (mg/l)

	Gravelly Pond	Lincoln Street Well
Turbidity	1.0	1.2
Sediment	0	0
Color	15	15
Odor	0	0
pH	7.4	7.2
Alkalinity-Total	22	23
Hardness	32	35
Calcium	9.0	10
Magnesium	2.3	2.5
Sodium	10	13
Potassium	0.9	1.0
Iron	.06	.08
Manganese	.04	.04
Sulfate	10	8
Chloride	20	19
Spec. Cond. (u/cm)	125	141
Nitrogen (ammonia)	<0.02	<0.02
Nitrogen (nitrate)	0.1	0.1
Nitrogen (nitrite)	.002	<.002
Copper	<.03	.24

Source: DEQE Water Quality Data

MANCHESTER WATER TREATMENT

Manchester's drinking water receives a variety of treatments at each of its sources. Round Pond Well water quality tests high for iron at 11 ppm and for manganese at 0.3 ppm. Water from this well is treated with chlorine, which promotes oxidation and causes some of the iron and manganese to precipitate out in the settling lagoon before the water enters Gravelly Pond. This oxidation process lowers the iron and manganese contents to 2.3 ppm and 0.12 ppm respectively. Water from Gravelly Pond is chlorinated to control bacteria and both Lincoln St. Well and Gravelly Pond are treated with sodium tri-polyphosphate to control corrosion and with fluoride (see Table 2-28).

Table 2-28
Manchester Water Treatment

Source	Chlorine	Sodium Tri-Polyphospate	Floride
Lincoln St. Well		X	X
Gravelly Pond	X	X	X
Round Pond Well	X		

Source: Manchester Water Department

MANCHESTER DISTRIBUTION AND STORAGE

Manchester's water distribution system comprises 34.61 miles of 6" or larger water mains.

Storage is provided in the Moses Hill standpipe which has a holding capacity of 1.02 million gallons.

WENHAM WATER USE AND CONSUMPTION

The Town of Wenham Water Commission supplies water to about 3,810 people which is 100% of Wenham's population. There are 1,032 service connections in the service area. In 1987 the system delivered a total of 123,667,000 gallons, with an average day demand of 338,813 gallons and a maximum day demand of 1,173,000 gallons. Water use falls into the following major categories:

Residential	82.3%
Agricultural	0.2%
Commercial	1.7%
Municipal	2.1%
Industrial	0.3%
Unaccounted-for	13.4%
Total	100.0%

Over the last eight years, average day demand has fluctuated between 0.25 million gallons per day (mgd) and 0.34 mgd. Maximum day demand has fluctuated between 0.81 mgd and 1.17 mgd for the same time period, with peak demands reached in 1983 for average day demand and in 1987 for maximum day demand (see Table 2-29 and Figure 2-11).

Figure 2-11

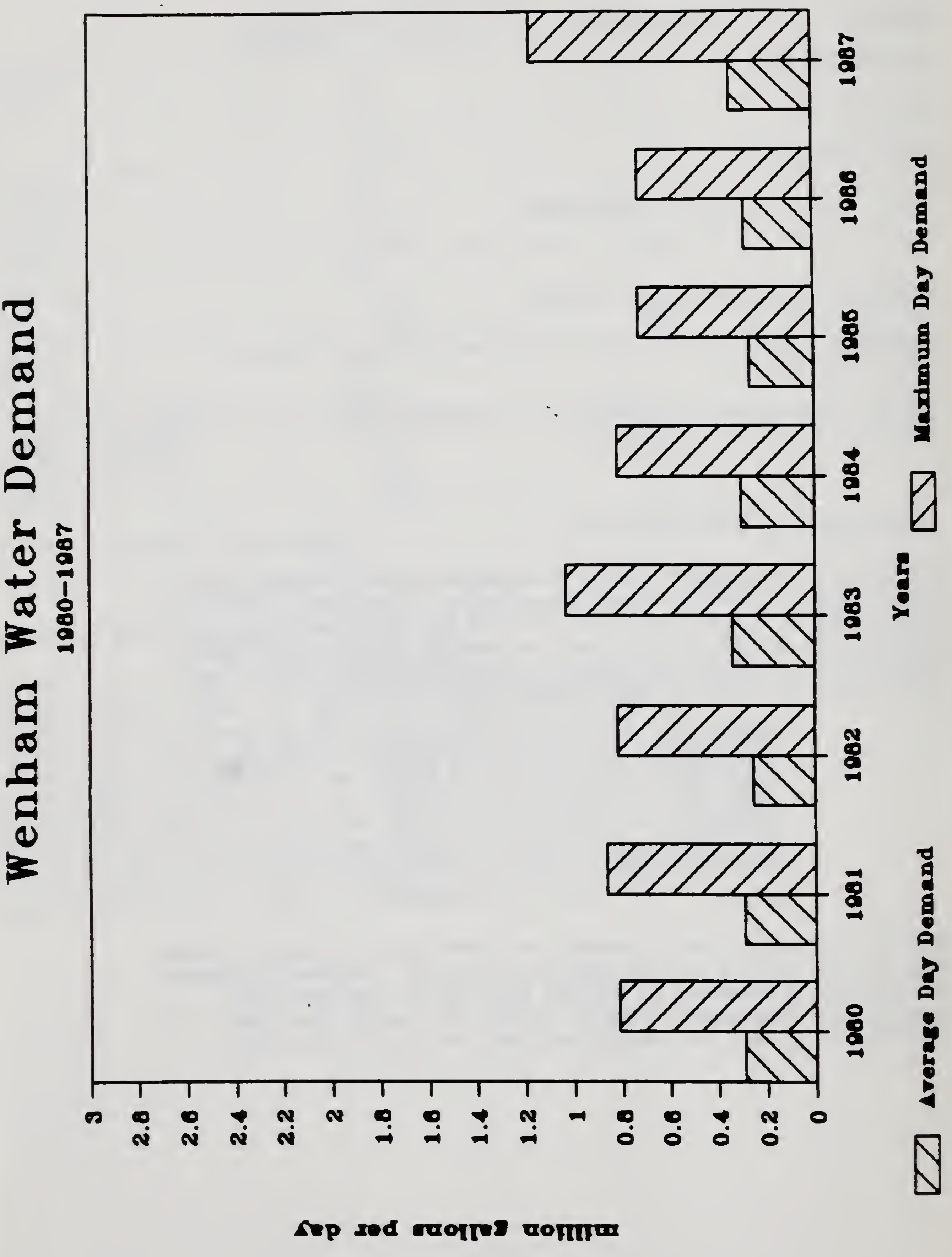

Wenham Water Demand
1980–1987
million gallons per day
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1980
1981
1982
1983
1984
1985
1986
1987
Years
Average Day Demand
Maximum Day Demand

Table 2-29
Wenham Historic Water Use

Year	Average Day (mgd)	Maximum Day (mgd)
1987	0.34	1.17
1986	0.28	0.72
1985	0.26	0.72
1984	0.30	0.81
1983	0.34	1.03
1982	0.25	0.81
1981	0.29	0.86
1980	0.29	0.81

Source: DEQE Water Supply Data

Projections of future demand made by the Department of Environmental Management estimate that by the year 2020, average day demand will be 0.34 mgd and maximum day demand will be 0.99 mgd (see Table 2-30 and Figure 2-12). However, by comparing Tables 2-29 and 2-30, it is evident that future demand projections are low considering that the 1990 projection was exceeded in 1987.

Table 2-30
Wenham Future Demand Projections

Year	Average Day (mgd)	Maximum Day (mgd)
1990	0.30	0.87
2000	0.31	0.90
2010	0.33	0.96
2020	0.34	0.99

Source: DEM Ipswich River Water Study

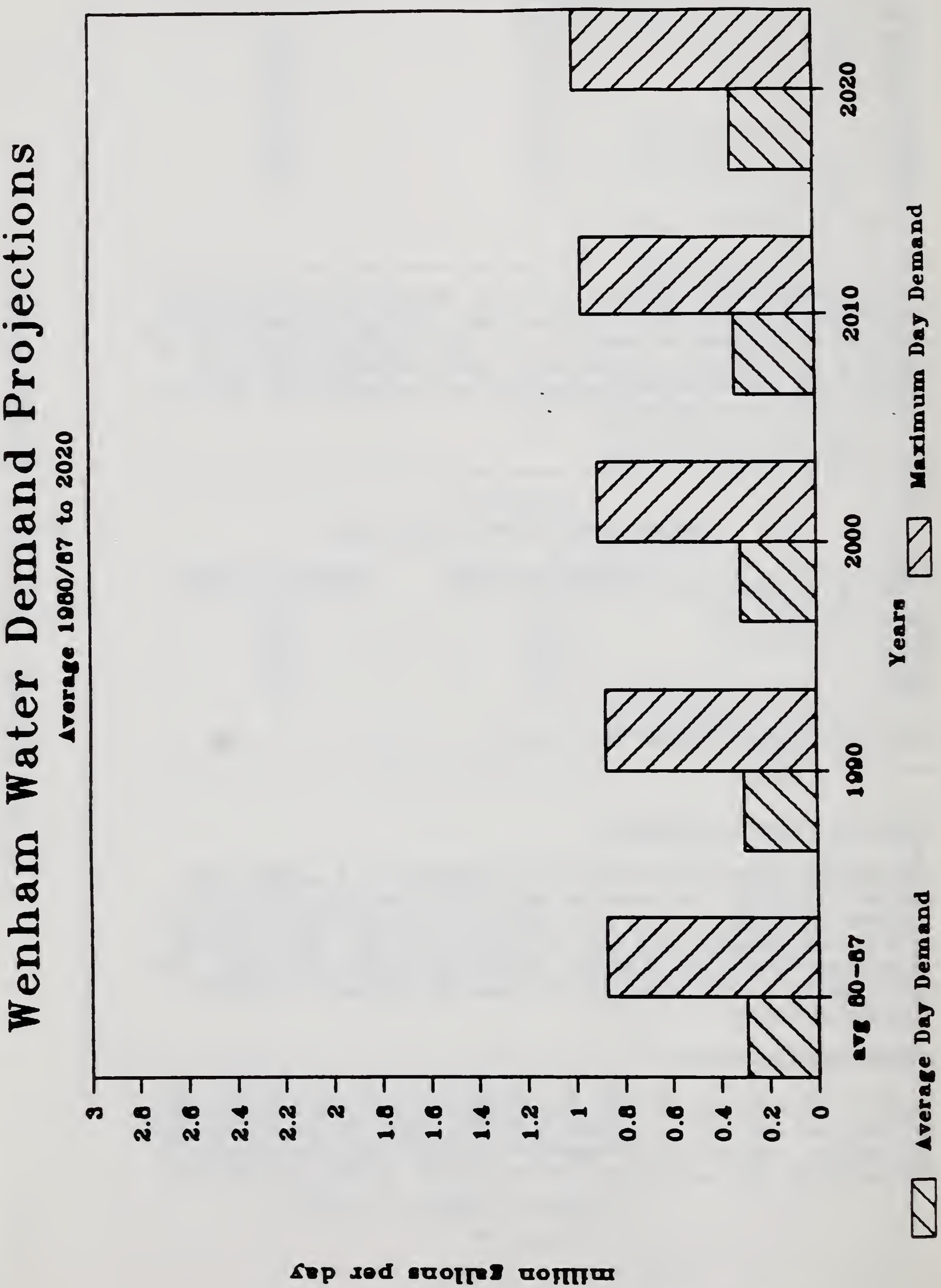
WENHAM WATER SUPPLY SOURCES

The Town of Wenham relies solely on groundwater as a public water source. The Water Commission operates two gravel pack wells with a combined safe yield of 1.51 mgd. Well #1 was installed in 1953 and is a 24-inch diameter well with a yield of 300 gpm. Well #2 is an 18-inch well with a yield of 750 gpm and was installed in 1958. The well field is located about 300 ft. south of Pleasant Pond off of Pleasant Street.

WENHAM EMERGENCY SOURCES

Wenham is able to meet current and projected average day demand with Well #1, and uses Well #2 primarily in the summer months to meet peak day demands. Wenham has arrangements to supply Hamilton and Beverly with water during emergencies, and vice versa, through a pipe valve

Figure 2-12


Wenham Water Demand Projections
Average 1980/87 to 2020
million gallons per day
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
avg 80-87
1990
2000
2010
2020
Years
Average Day Demand
Maximum Day Demand

system involving two pipes to Hamilton and one to Beverly. Wenham has no other sources of water within the town.

WENHAM WATER QUALITY

The quality of Wenham's water meets all requirements of the Safe Drinking Water Act regulations. Table 2-31 draws the results of water quality analysis in 1987.

Table 2-31
Wenham Drinking Water Quality in 1987 (mg/l)

	Well #1	Well #2
Turbidity	0.1	0.1
Sediment	0	0
Color	0	0
Odor	0	0
pH	7.5	7.8
Alkalinity-total	98	138
Hardness	126	216
Calcium	41	63
Magnesium	5.6	14
Sodium	14	18
Potassium	2.6	3.3
Iron	<.04	<.04
Manganese	.04	.21
Sulfate	34	54
Chloride	25	27
Spec. Cond. (u/cm)	323	419
Nitrogen (Ammonia)	0.03	<0.02
Nitrogen (Nitrate)	0.9	2.0
Nitrogen (Nitrite)	0.009	0.026
Copper	<.03	<.03

Source: DEQE Water Quality Data

WENHAM POTENTIAL FUTURE SOURCES

Wenham is not actively pursuing alternative sources of water at this time. The main aquifer is large and dependable and the town can put another well into the same area if increased flow is needed.

The town has investigated two other sources in the past but neither proved viable. Wells were drilled in the Miles River area, but the sediments were non-productive so this area has been discounted. The town also investigated the Town Rail Complex where the town garage is located, but this aquifer has a very low yield and proved inconsistent in pump tests. It may be able to be tapped for emergency purposes but only for a couple of months at a time.

WENHAM WATER TREATMENT

The water is treated with a common injection of floride.

WENHAM DISTRIBUTION AND STORAGE

Wenham's water distribution system consists of 26.89 miles of 8" or larger mains.

Storage is provided in two welded steel tanks. The Friend Court tank, built in 1946, holds .5 million gallons and is 27 ft. x 120 ft. tall. The Lord's Hill tank, built in 1958, holds .75 million gallons and is 60 ft. x 35 ft. tall. Total system storage is 1.25 mg.

CHAPTER 3

WATER RESOURCES AND ENVIRONMENTALLY SENSITIVE AREAS

GEOLOGY

The bedrock geology in the North Shore study area consists primarily of Paleozoic age material. The northwest section of this area is characterized by Ordovician gabbro-diorites, Cambrian volcanics and Ordovician granites. Southeast of these are Ordovician granites with some Cambrian volcanics and Ordovician gabbro-diorites. These are dense, resistent rock materials containing many heavy minerals such as iron and manganese.

The entire New England area has experienced glaciation during the Pleistocene Epoch, with the most recent glaciation in the Wisconsinan Stage. The glaciers carved and smoothed the underlying bedrock and then covered the bedrock with unconsolidated materials of varying depths. The materials deposited by the glaciers fall into two main categories: 1) the materials deposited as the ice advanced, called till, and 2) those materials deposited as the ice retreated, or glacialfluvial features.

Tills are composed of unconsolidated materials with a high clay content and are therefore low to non-permeable for groundwater transport, however, they can hold a lot of water. In the New England area tills are found in the form of ground moraines and drumlins. Till does not make a good aquifer but can be a good confining layer for subsequent glaciofluvial and post-glacial deposits.

Glaciofluvial features are characterized by stratified sand, silt and gravel deposits which were laid down as the ice melted and washed out the clay particles. In the Ipswich River area, a variety of glaciofluvial features in the form of kames, kame terraces, eskars, kame deltas, collapsed stratifed drift and outwash plains are found. These forms exhibit sedimentary structures, composed of well sorted sediments, ranging from 15 to 30 feet deep. Stratified drift deposits in the form of long linear depressions are frequently found as "buried valleys" in the underlying bedrock. These deposits represent pre-glacial drainage depressions which were then filled with meltwater materials. Stratified drift deposits make excellent aquifers.

In addition, there are also marine and estuarine deposits and swamp and marsh deposits in the New England area. The marine and estuarine deposits were formed immediately after the glaciers left New England. This area was depressed below sea level under the weight of the ice and when the ice retreated, before the area rebounded, the oceans moved in and deposited marine clays and silts. These deposits have a low permeability and transmissivity and are found in the eastern portions of Hamilton, Wenham and Beverly and throughout Essex and Manchester in thicknesses less than 15 feet. These deposits make poor aquifers.

On the other hand, swamp and marsh deposits usually store significant amounts of groundwater, though their transmissivity varies. These deposits have formed since glacial times and are composed of matted organic materials interbedded with sands and silts. Swamp and marsh deposits are found throughout the North Shore study area.

GROUNDWATER

The occurrence of groundwater is controlled by the surficial and bedrock geology. Aquifers which yield sufficient quantities of water for public supply wells are generally found in thick deposits of sand and gravel, which are capable of storing and transmitting significant amounts of water. Ice contact deposits and fine grained glacial outwash deposits have the best potential as aquifers due to their ability to store and release water. While tills can hold large amounts of water, they are unable to release the water due to extremely low transmissivity caused by the abundant clay content. Deposits with very high transmissivity transfer the water too quickly or may not be able to contain it for storage purposes. Therefore, a moderate to high transmissivity is preferred. In the New England area, aquifers which produce at least 150,000 gallons per day or 100 gallons per minute are considered most suitable for municipal supply. In order to produce these volumes, thicknesses of at least 25 feet with transmissivities of at least 10,000 gallons per day per foot are considered optimal.

In the Hamilton/Ipswich area, ice contact deposits in stream valleys on till and bedrock slopes form fair aquifers. In the southern Hamilton and Wenham areas and in northern Beverly, coarse grained materials from ice contact are found, though they are too thin in most areas to be considered for aquifers. In the Salem and Beverly area, a 1964 study of groundwater sources in the Ipswich River Basin found viable yields of groundwater. The North Coastal drainage area is characterized by marine clays and so has poor potential for productive aquifers.

According to U.S.G.S. data, there are four high potential yield aquifers in the North Shore study area totalling 1,891 acres. They are located in Hamilton, Wenham and Beverly. The largest aquifer is shared by Hamilton and Wenham and is tapped for municipal supply by both towns. The sizes and locations of the aquifers are summarized in Table 3-1.

Table 3-1
High Potential Yield Aquifers

Total Acres	Town	Acres by Town	% Aquifer In Town
953	Hamilton (West)	366	38%
	Wenham	587	62%
580	Hamilton	551	95%
	Wenham	29	5%
251	Beverly	208	83%
	Wenham	43	17%
107	Hamilton (East)	107	100%

Eight moderate potential yield aquifers underlay 5,388 acres of the study area. the largest moderate yield aquifer is shared by Hamilton, Beverly and Wenham and a smaller aquifer is shared by Manchester and Essex. The other six moderate yield aquifers are wholly within a town's boundary. The breakout for these aquifers in order of acreage follows:

Table 3-2
Moderate Potential Yield Aquifers

Total Acres	Town	Acres by Town	% Aquifer In Town
5065	Beverly	380	7%
	Hamilton	2934	58%
	Wenham	1751	35%
115	Beverly	115	100%
71	Essex	71	100%
53	Hamilton	53	100%
33	Essex	14	42%
	Manchester	19	58%
32	Manchester	32	100%
13	Essex	13	100%
6	Manchester	8	100%

Essex and Manchester aquifers are in the North Coastal drainage area which is composed primarily of rock ledge and marine clays. Wenham, Hamilton and Beverly aquifers are in the more productive Ipswich Basin which contains many glaciofluvial deposits.

It is important to note that the high and moderate yield aquifers delineated by U.S.G.S. are not derived from actual hydrogeologic studies, but are inferred from geomorphologic data. Hydrogeologic studies have been conducted in Hamilton and Wenham, and in a later section of this chapter, a water supply study area will be defined according to hydrogeologic studies prepared by the towns.

SURFACE WATER

The North Shore study area lies within the eastern drainage basin of the Ipswich River and part of the North Coastal drainage basins. Within the study area, most of the towns of Hamilton and Wenham and part of Beverly lie within the Ipswich basin, all of Essex and Manchester and small parts of Hamiton and Wenham are in the North Coastal basins. Surface waters used for public water supply include the Ipswich River and three reservoirs in the Ipswich basin, which are used by the Salem and Beverly Water Supply Board, and Gravelly Pond in the north coastal basin, which is used by Manchester. Round Pond, also in the North coastal basin, contributes to Manchester's Round Pond well and is being considered as an additional surface water supply for Manchester. All surface water sources in the study area are fully utilized by neighboring communities, rather than the towns in which they are located (except Wenham Lake, which is partially located in Beverly). The reservoirs and their capacities and watershed areas are summarized in Table 3-3. There are five reservoirs in the study area with a total capacity of 3.7 billion gallons and a combined watershed area of 5,634 acres. Ninety-five percent of the capacity and 93 percent of the watershed areas are in the Ipswich basin.

Table 3-3
Surface Water Supplies

Water System	Source	Storage Capacity (mil.gal.)	Watershed Area (Acres)	Location
Beverly/Salem	Ipswich River	(diversion)	--	Danvers
Beverly/Salem	Wenham Lake	1,200	1,562	Wenham/ Beverly
Beverly/Salem	Longham Res.	50	2,189	Wenham
Beverly/Salem	Putnamville Res.	2,300	544	Danvers/ Topsfield
Manchester	Gravelly Pond	100	426	Hamilton
Manchester	Round Pond	90	913	Hamilton
TOTAL		3,740	5,634	

WATER SUPPLY STUDY AREA

For the purposes of this study, a water supply study area will be defined which includes all lands which contribute groundwater or surface water to wells or reservoirs used for municipal water supply. The water supply study area is delineated on Map 1 and described below.

For the surface water sources, the watershed areas shown on Map 1 and listed in the preceding section are included in the study area. This includes the drainage areas of Wenham Lake, Longham Reservoir, Putnamville Reservoir, Gravelly Pond, and Round Pond. With the exception of the Wenham Lake watershed, these areas have been clearly delineated. In the case of Wenham Lake, questions have been raised about the exact location of a portion of the watershed boundary in Beverly. The boundary used in this study was provided by the Salem and Beverly Water Supply Board.

For the groundwater sources, the aquifers in Hamilton and Wenham which have been delineated by hydrogeologic studies are included in the study area. In Essex and Manchester, hydrogeologic studies have not been conducted to delineate aquifer boundaries (although Essex is currently conducting such studies). For these two communities, an interim study area boundary has been delineated which includes the watersheds in which the municipal wells are located. This includes the Essex River watershed for Essex's wells and the Sawmill Brook watershed for Manchester's well. This delineation is intended for study purposes only. In order to delineate a legally defensable protection district, hydrogeologic studies would need to be conducted in the aquifers of these communities.

It is important to note that several of these regions overlap. The Wenham Lake Watershed which supplies Beverly is underlain by part of the large Wenham Swamp aquifer (which is tapped by Wenham and Hamilton). Also, in a more complex case, the Essex River Watershed is shared by the Gravelly and Round Pond Watersheds and parts of these three subbasins are underlain by a portion of the Hamilton East Aquifer.

The acreages of the watersheds and aquifers in the water resources study area are summarized in Table 3-4. The boundaries of the study area are indicated in Figure 3-1.

Table 3-4
Water Resources Study Area

Watershed Areas	Acres
Wenham Lake	1,562
Longham Reservoir	2,189
Putnamville Reservoir	544
Gravelly Pond	426
Round Pond	913
Aquifer Areas	
Wenham Swamp	3,334
Hamilton (east)	1,221
Manchester (Sawmill Brook watershed)	3,193
Essex (Essex River subbasin)	4,283
Total Area*	15,049

* Excluding areas of overlap between watersheds and aquifers.

INTERCOMMUNITY WATER RESOURCES

Many of the water resources in the study area are related to more than one community. In some cases, a watershed or aquifer crosses one or more community boundaries, and portions of the resource are located outside of the community where the water is used. In other cases, a water resource is located entirely outside of the community which uses it. Both situations raise concerns about the management and protection of water resources which are fragmented among the jurisdiction of several communities.

The intercommunity characteristics of the water resources in the study area are summarized in Table 3-5 and illustrated on Map 2. Tables 3-6 and 3-7 provide detailed breakdowns of the location of intercommunity watersheds and aquifers by acreage and percentage in each community. These are illustrated in Figures 3-2 and 3-3. Intercommunity water resource areas are delineated on Map 2.

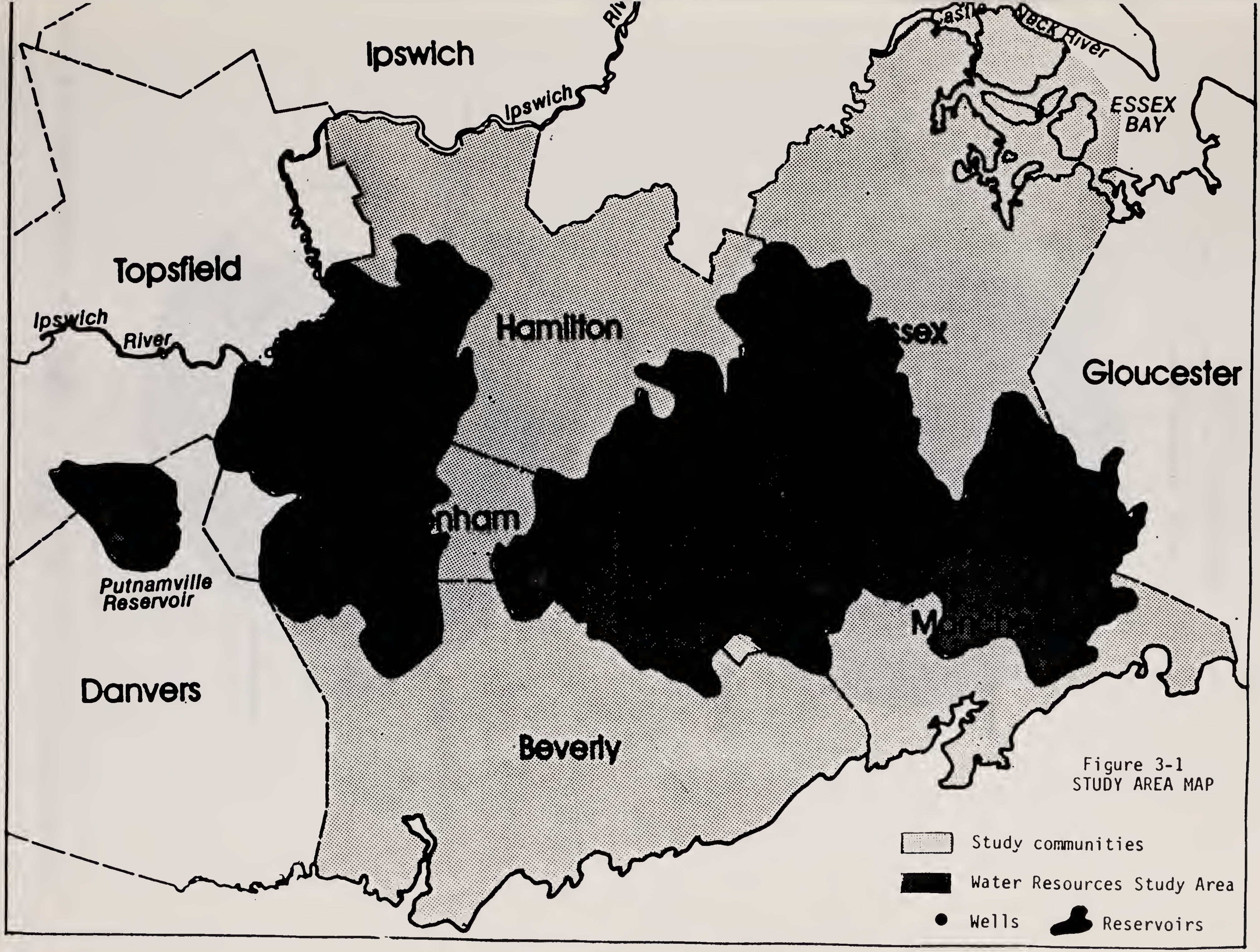


Figure 3-1
STUDY AREA MAP

Figure 3-2
Intercommunity Water Resource Areas

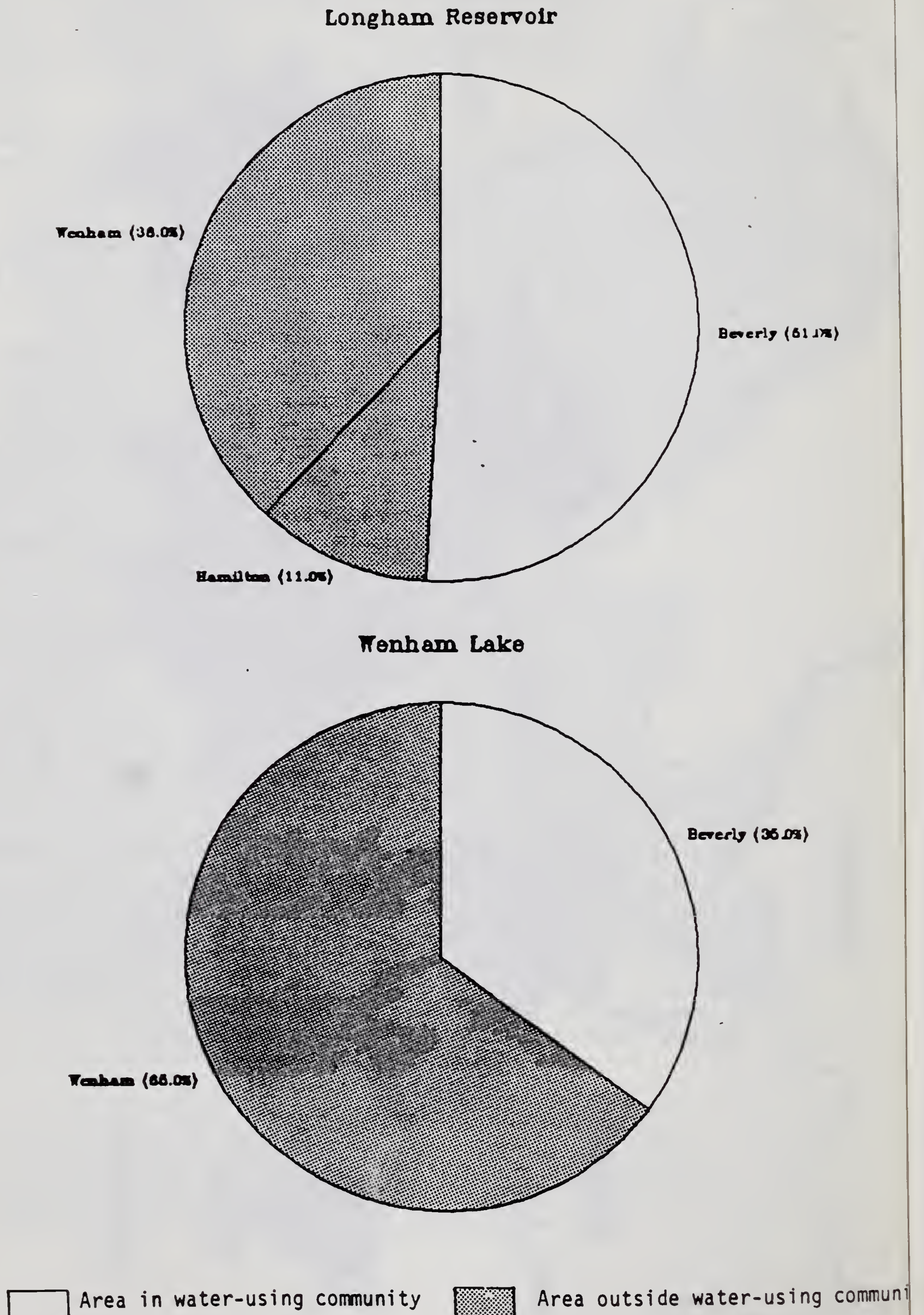
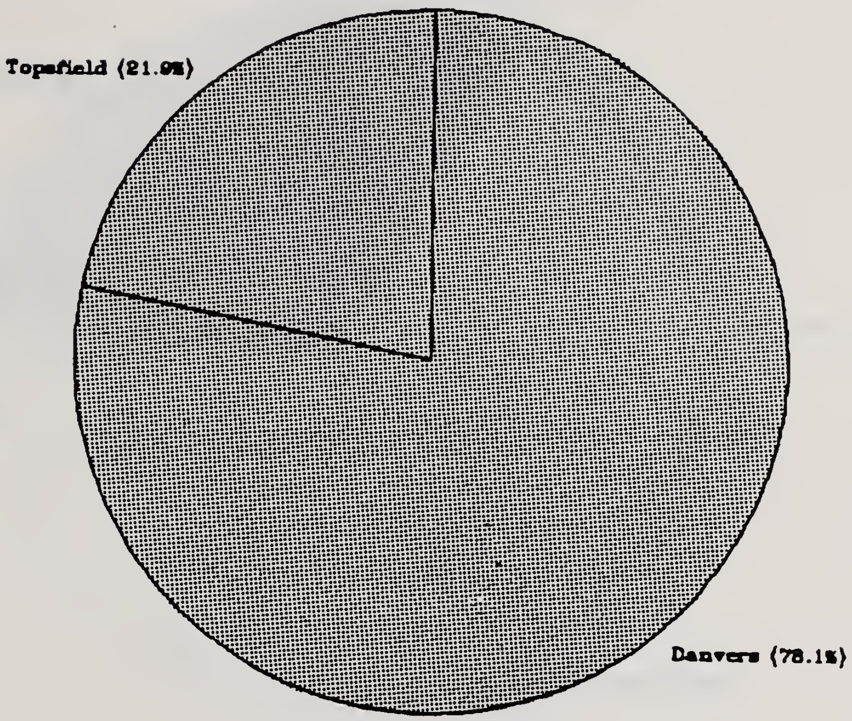
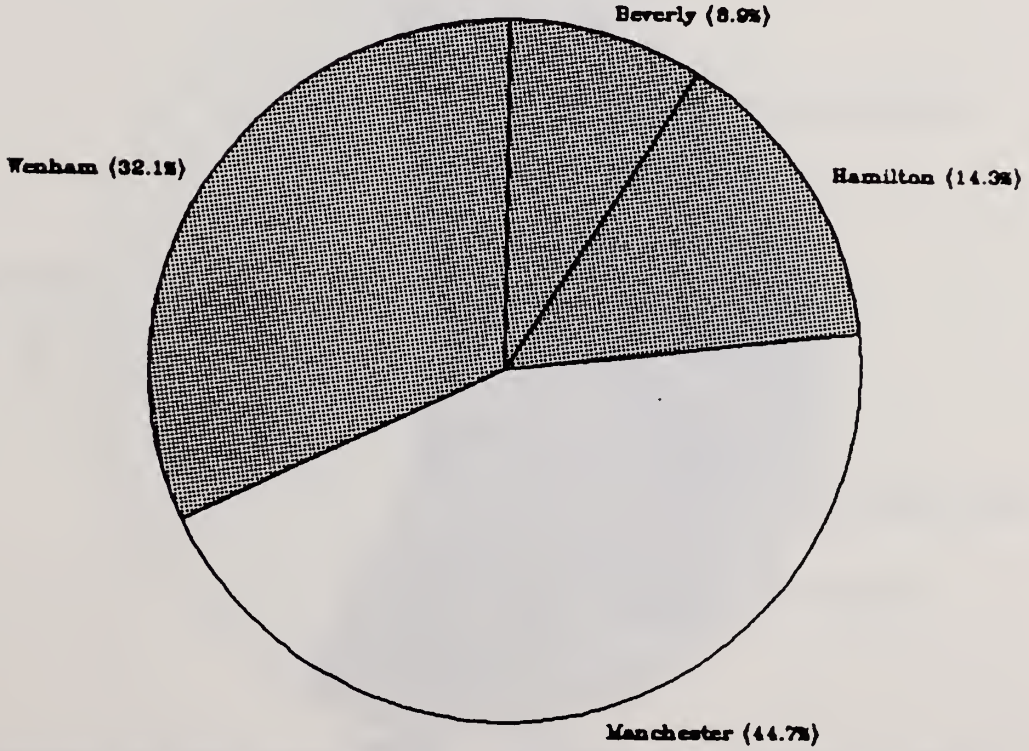


Figure 3-2 (continued)

Putnamville Reservoir

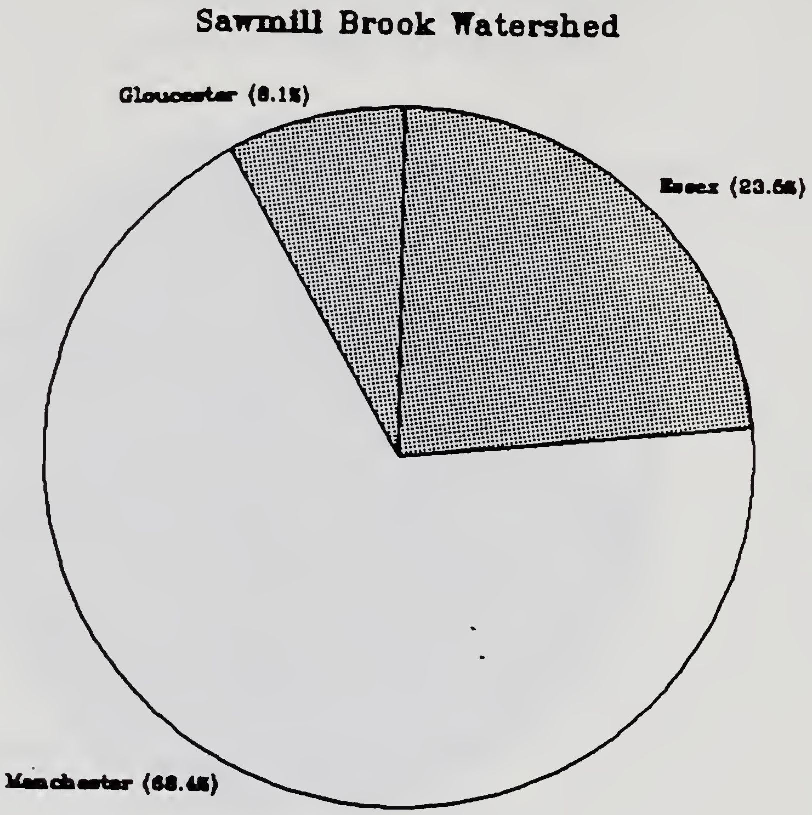


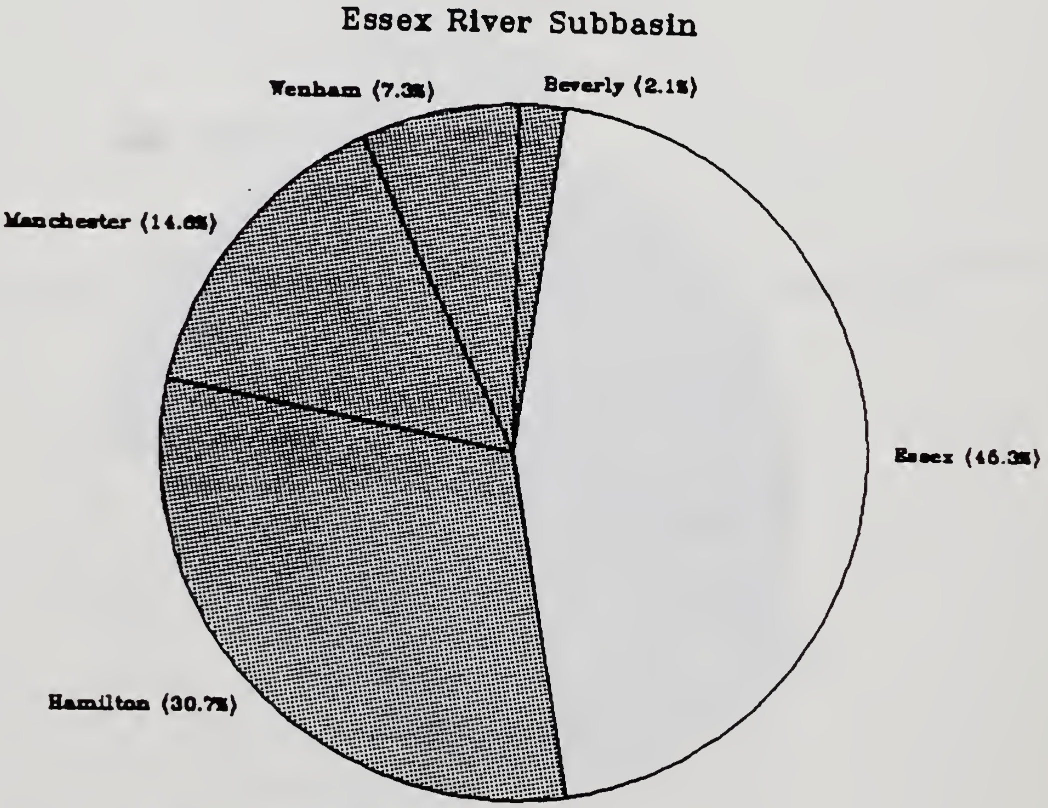
Round Pond



☐ Area in water-using community ▨ Area outside water-using community

Figure 3-2 (contiued)





☐ Area in water-using community ▨ Area outside water-using community

Figure 3-2 (continued)

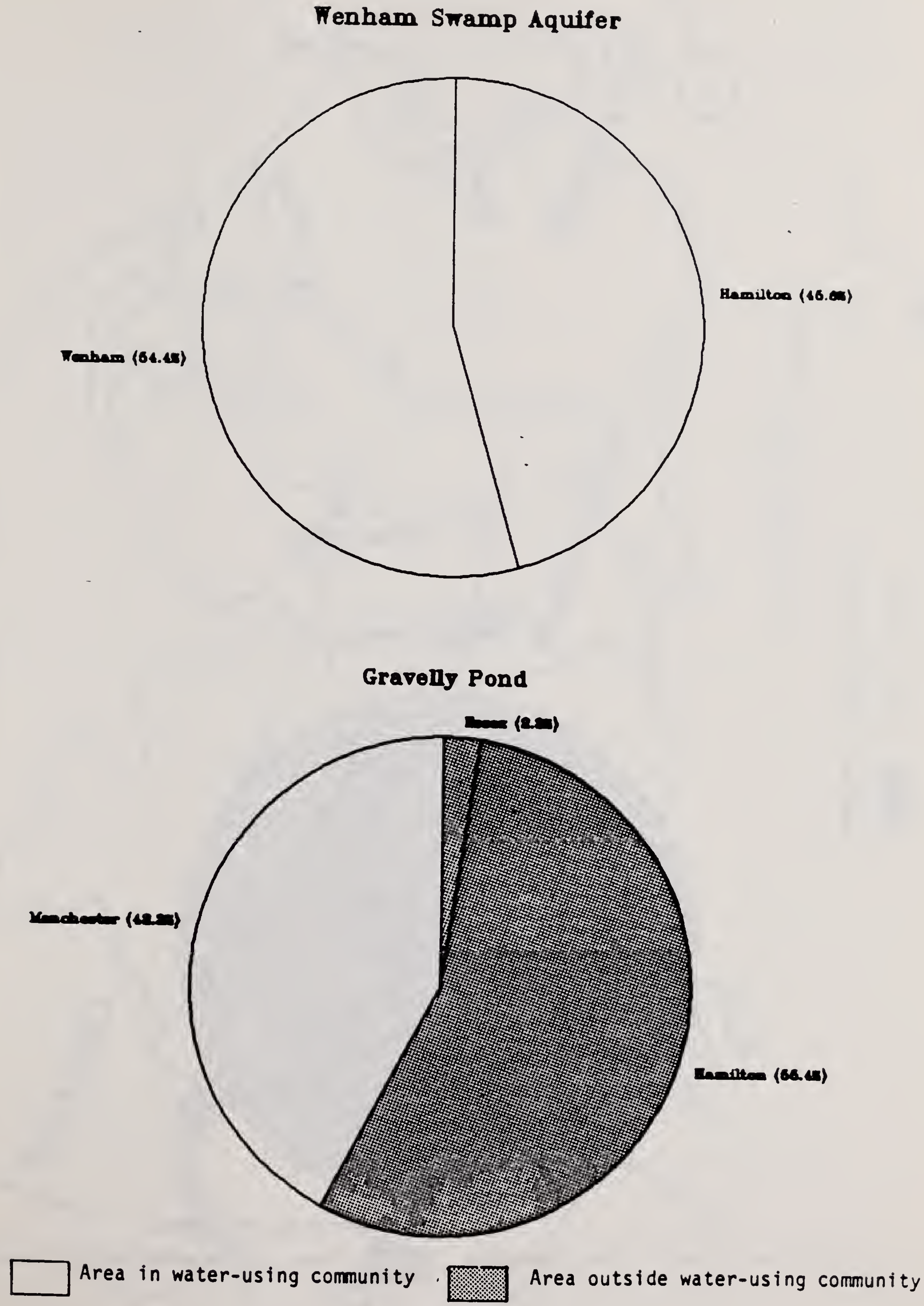
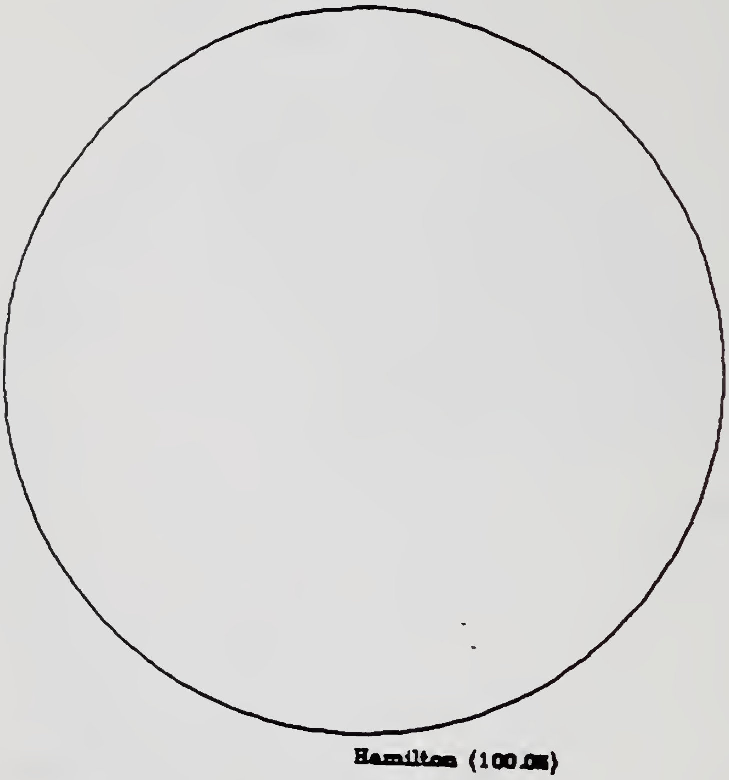
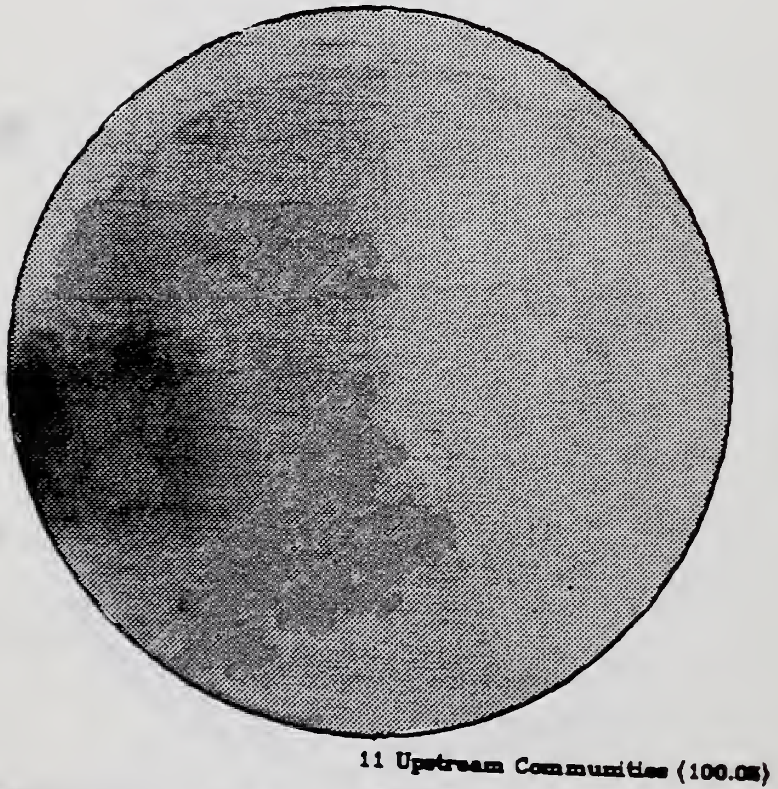


Figure 3-2 (continued)

Hamilton East Aquifer



Ipswich River



☐ Area in water-using community ▨ Area outside water-using community

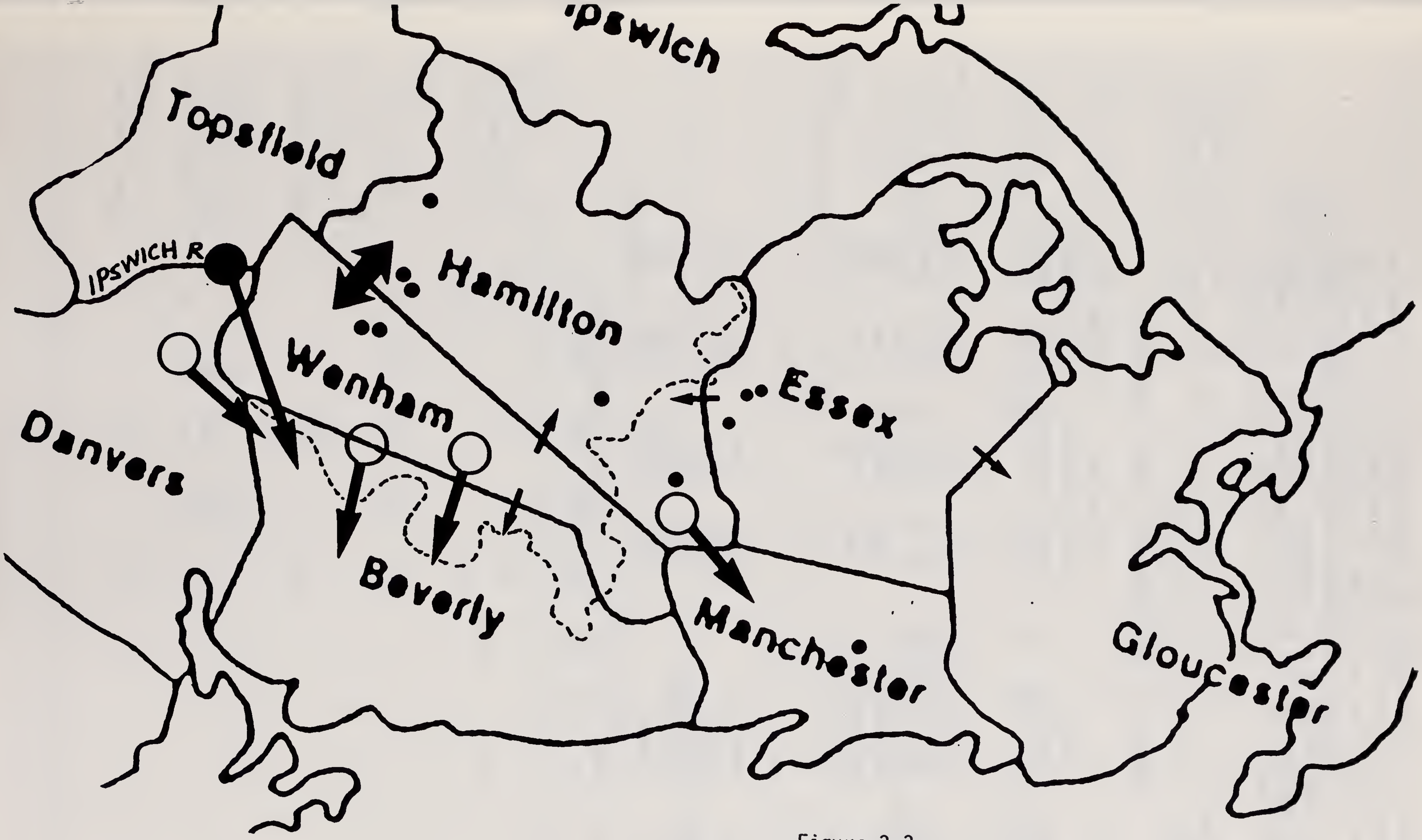


Figure 3-3
INTERCOMMUNITY WATER RESOURCES

→	TRANSFER OF WATER	○	RESERVOIR
⟷	SHARED AQUIFER	•	WELL
→	SYSTEM INTERCONNECTION	●	RIVER DIVERSION
- - -	IPSWICH RVER BASIN BOUNDARY		

The data shows the high degree of intercommunity relationships between all of the study area water resources. The proportion of watershed and aquifer areas located in neighboring communities (outside of the community which uses the water resource) ranges from 32 percent to 100 percent, and averages 57 percent. This highlights the need for cooperation and coordination among the communities for the management and protection of all drinking water resources.

Table 3-5

Summary of Intercommunity Water Resources

Water Resource	User Community	Area in User Community Acres	Area in User Community Percent	Area out of User Community Acres	Area out of User Community Percent
WATERSHEDS					
Wenham Lake	Beverly/Salem	547	35%	1,015	65%
Longham Res.	Beverly/Salem	1,116	51%	1,073	49%
Putnamville Res.	Beverly/Salem	0	0	544	100%
Gravelly Pond	Manchester	180	42%	246	58%
Round Pond	Manchester	408	45%	505	55%
Ipswich River	Beverly/Salem	0	0	*	100%
AQUIFERS					
Wenham Swamp	Hamilton	1,521	46%	1,813	54%
	Wenham	1,813	54%	1,521	46%
Hamilton (East)	Hamilton	1,221	100%	0	0
Sawmill Brook	Manchester	2,184	68%	1,009	32%
Essex River	Essex	1,941	45%	2,342	55%

* Watershed includes portions of 11 upstream communities

Table 3-6
Intercommunity Water Resources - Acreage Breakdown

	Bev	Ess	Ham	Man	Wen	Dan	Glo	Top	Total
Beverly									
Longham Res.	1,116	0	241	0	832	0	0	0	2,189
Putnamville	0	0	0	0	0	425	0	119	544
Wenham Lake	547	0	0	0	1,015	0	0	0	1,562
Essex									
Essex River	89	1,941	1,317	625	311	0	0	0	4,283
Hamilton									
E. Aquifer	0	0	1,221	0	0	0	0	0	1,221
Wenham Swamp	0	0	1,521	0	1,813	0	0	0	3,334
Manchester									
Sawmill Brook	0	749	0	2,184	0	0	260	0	3,193
Gravelly Pond	0	10	236	180	0	0	0	0	426
Round Pond	81	0	131	408	293	0	0	0	913
Wenham									
Wenham Swamp	0	0	1,521	0	1,813	0	0	0	3,334

Table 3-7
Intercommunity Water Resources - Percentage Breakdown

	Bev	Ess	Ham	Man	Wen	Dan	Glo	Top
Beverly								
Longham Res.	51%		11%		38%			
Putnamville						78%		22%
Wenham Lake	35%				65%			
Essex								
Essex River	3%	45%	31%	15%	7%			
Hamilton								
E. Aquifer			100%					
Wenham Swamp			46%		54%			
Manchester								
Sawmill Brook		24%		68%			8%	
Gravelly Pond		2%	56%	42%				
Round Pond	9%		14%	45%	32%			
Wenham								
Wenham Swamp			46%		54%			

CHAPTER 4

LAND USE AND WATER SUPPLY IMPACTS

This chapter describes the uses of land in the North Shore Water Study Area and examines the potential impacts of land use on the quality and quantity of water supply sources in the five communities. After a brief review of the recent growth and development trends of the area, water supply impacts will be addressed in terms of the potential sources of contamination associated with land use.

HISTORIC DEVELOPMENT TRENDS

This section reviews the last three decades of growth and development in each of the communities. This perspective aids in understanding the existing land uses, as it provides information on past activities that today may affect the water supply sources.

POPULATION TRENDS

The total population in the North Shore study area grew 1.7 times between 1950 and 1986. The highest rate of growth occurred between 1950 and 1970. Populations have stabilized in the 1970's and 1980's and have since decreased slightly for the region (see Table 4-1). A summary of population trends for each of the communities in the study area follows.

Table 4-1
North Shore Study Area Population Data, 1950-1986

Year	Population	Population density per square mile	% Change
1950	37,954	621	16%
1960	50,564	827	33%
1970	56,391	922	12%
1980	56,924	931	1%
1986	56,150	918	-1%

* Based on 61.16 square miles in the five communities.

Beverly

Table 4-2 summarizes the population and population density of Beverly between 1950 and 1986. The data show that the 1986 population is 1.4 times what it was in 1950. The highest rate of growth occurred before 1960. Since then, the population has remained relatively stable.

Table 4-2
Beverly Population Data, 1950-1986

Year	Population	Population density per square mile*	% Change
1950	28,884	1,862	13%
1960	36,108	2,328	25%
1970	38,348	2,472	6%
1980	37,655	2,428	-2%
1986	39,980	2,578	6%

* Based on 15.51 square miles in Beverly.

Essex

Between 1950 and 1986, the population in Essex grew 1.6 times. The highest rate of growth occurred early in the period. Since 1980, population in Essex has stabilized (see Table 4-3).

Table 4-3
Essex Population Data, 1950-1986

Year	Population	Population density per square mile*	% Change
1950	1,794	123	30%
1960	2,238	153	25%
1970	2,670	183	19%
1980	2,998	205	12%
1986	2,960	203	-1%

* Based on 14.59 square miles in Essex.

Hamilton

Hamilton's 1986 population grew to 2.6 times what it was in 1950. The highest rate of growth occurred between 1950 and 1970 (see Table 4-4). Since 1970, Hamilton's growth has slowed considerably.

Table 4-4
Hamilton Population Data, 1950-1986

Year	Population	Population density per square mile*	% Change
1950	2,764	185	36%
1960	5,488	367	99%
1970	6,373	426	16%
1980	6,960	465	9%
1986	7,140	477	3%

* Based on 14.96 square miles in Hamilton.

Manchester

Between 1950 and 1986, Manchester's population increased 1.8 times. The highest growth rates occurred between 1950 and 1970 (see Table 4-5). Since 1970, population has stabilized and declined.

Table 4-5
Manchester Population Data, 1950-1986

Year	Population	Population density per square mile*	% Change
1950	2,868	368	16%
1960	3,932	505	37%
1970	5,151	661	31%
1980	5,424	696	5%
1986	5,260	675	-3%

* Based on 7.79 square miles in Manchester.

Wenham

Wenham's population grew 2.3 times from 1950 to 1986. As with several of the other towns, Wenham's highest rate of growth occurred between 1950 and 1970 (see Table 4-6). Since 1970, population in Wenham has stabilized.

Table 4-6
Wenham Population Data, 1950-1986

Year	Population	Population density per square mile*	% Change
1950	1,644	198	35%
1960	2,798	337	70%
1970	3,849	463	38%
1980	3,897	469	1%
1986	3,810	458	-2%

* Based on 8.31 square miles in Wenham.

LAND USE TRENDS

The historic population growth in these communities is reflected in the changing land uses over the last 30 years. The following data on historic land use was taken from a study by William MacConnell of the University of Massachusetts, who has classified and mapped land uses by interpretation of aerial photography. The minimum parcel size mapped was three acres. Map 3 shows land use in 1980, and the following tables and figures show the breakdown of land uses for 1951 and 1980 for each of the North Shore communities.

"Developed" land uses, for the five communities, increased 102% from 1951 to 1980. Residential development showed the largest gain in absolute acres, with an increase of 3,672 acres. Commercial land uses showed the highest percentage increase, with 129%. "Undeveloped" land uses dropped 5,037 acres, or 15%. Agricultural land diminished by 2,930 acres or 48%, a loss that was greater than any other single land use (see Table 4-7). Figure 4-1 graphically demonstrates land use changes in the major land use categories from 1951 to 1980.

Figure 4-1

NORTH SHORE LAND USE CHANGE, 1951-1980

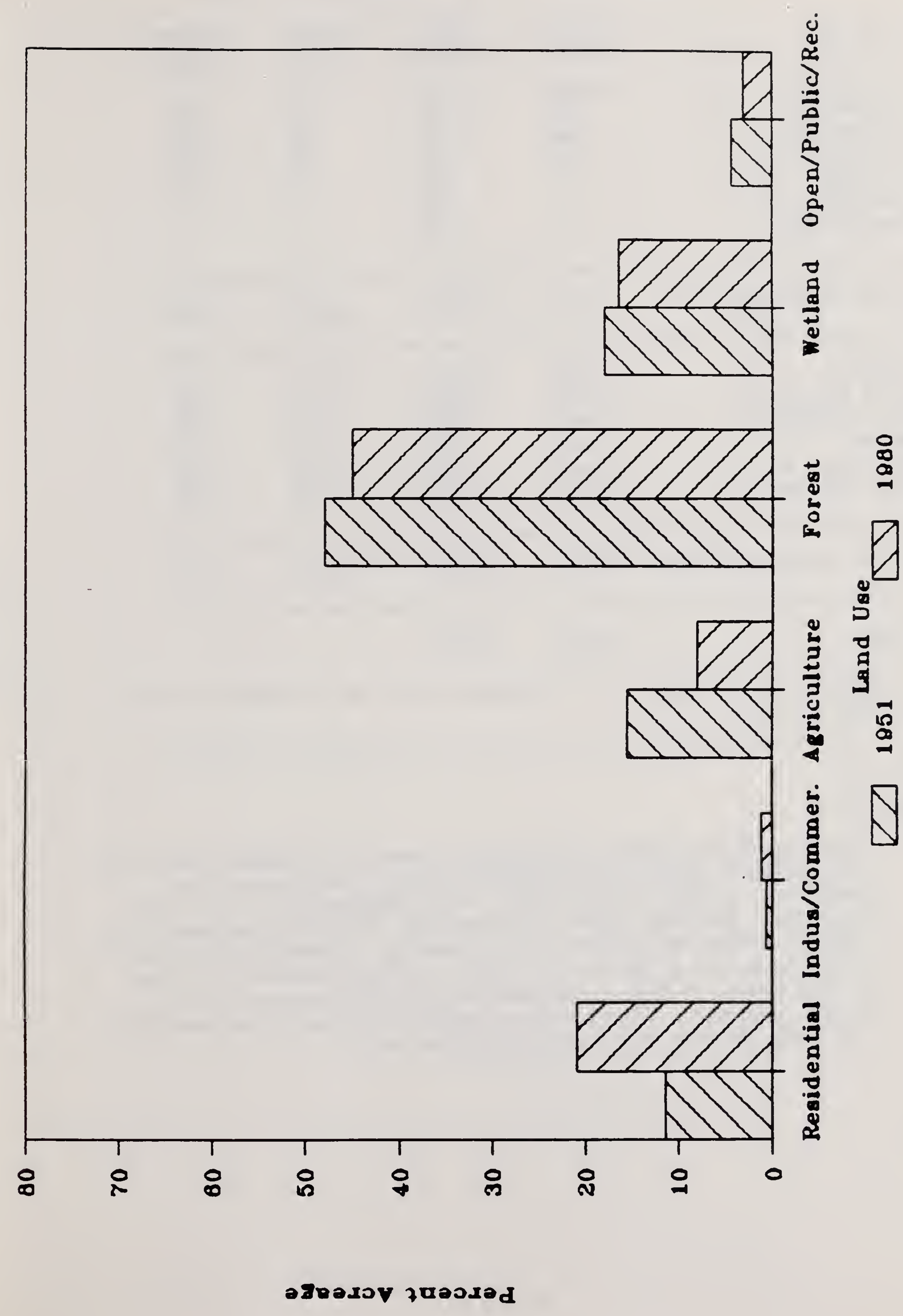


Table 4-7
North Shore Study Area Land Use Change, 1951-1980

Land Use	1951 (acres)	1980 (acres)	Change (acres)	Percent Change
Residential	4,484	8,156	3,672	82%
Industrial	65	81	16	25%
Commercial	147	336	189	129%
Transportation	246	455	209	85%
Mining*	--	160	--	--
Waste Disposal*	--	30	--	--
Recreation*	--	761	--	--
Total developed land	4,942	9,979	5,307	102%
Forests	18,755	17,578	-1,177	-6%
Salt Wetlands	2,442	2,322	-120	-5%
Fresh Wetlands	4,604	4,100	-504	-11%
Water	647	861	214	33%
Agriculture	6,063	3,143	-2,920	-48%
Open and Public	1,688	1,158	-530	-31%
Total undeveloped land	34,199	29,162	-5,037	-15%
TOTAL	39,141	39,141		

* Mining, Waste Disposal and Recreation were not included in the 1951 survey.

Beverly

"Developed" land uses in the City of Beverly increased nearly 50% from 3,042 to 4,424 acres (see Table 4-8). An increase in commercial acreage of 159 acres is the largest gain in any one land use. The 120% growth of commercial land also represents the highest percentage growth rate in Beverly. "Undeveloped" land uses dropped by 1,382 acres, or 20%. An agricultural land loss of 832 acres, or 65%, represents the greatest decrease in a single land use. Figure 4-2 shows the relationship between 1951 and 1980 land use for the major categories.

Figure 4-2

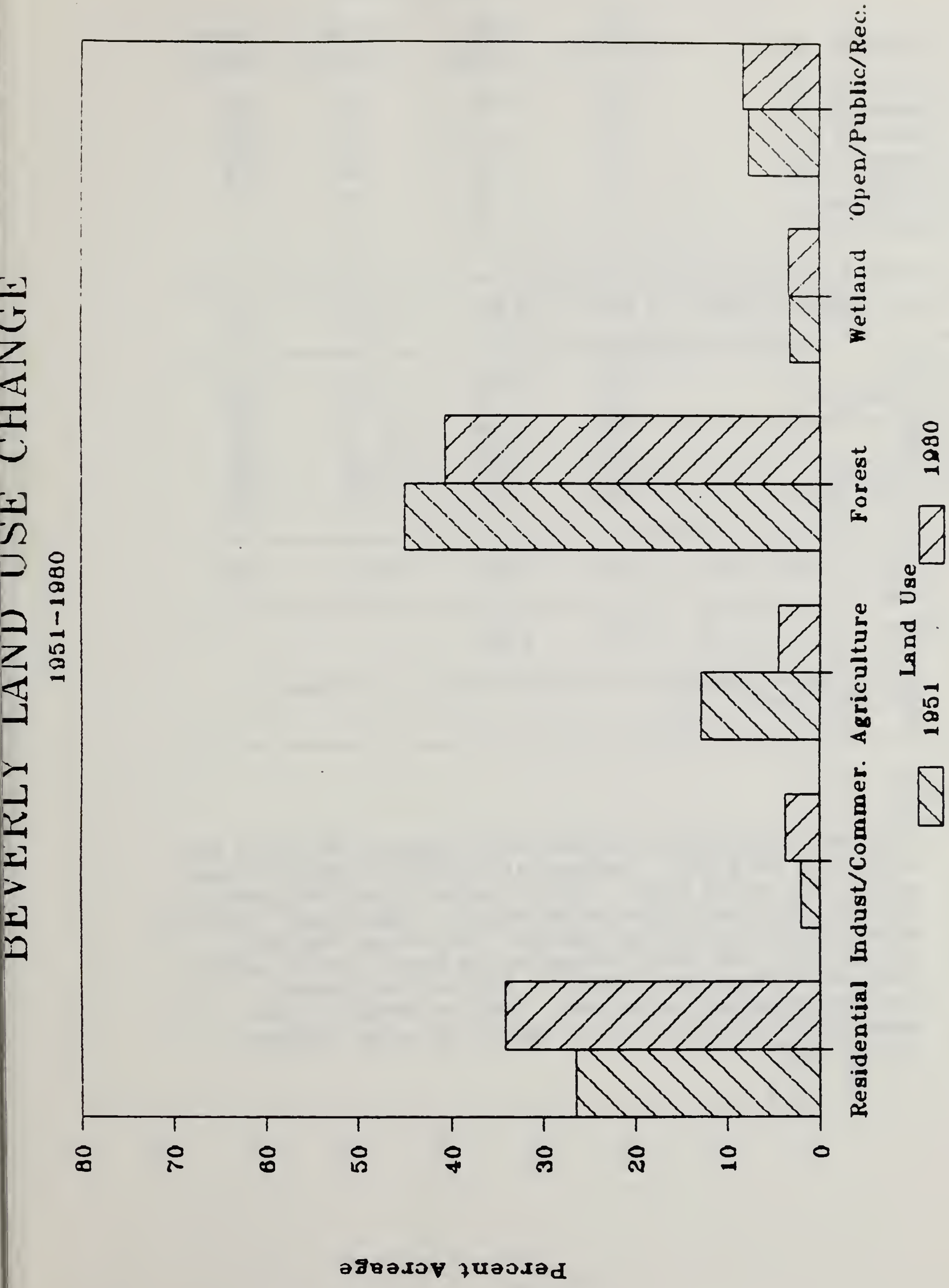

BEVERLY LAND USE CHANGE
1951-1980
Percent Acreage
0
10
20
30
40
50
60
70
80
Residential
Indust/Commer.
Agriculture
Forest
Wetland
Open/Public/Rec.
Land Use
1951
1980

Table 4-8
Beverly Land Use Change, 1951-1980

Land Use	1951 (acres)	1980 (acres)	Change (acres)	Percent Change
Residential	2,618	3,387	769	29%
Industrial	63	76	13	21%
Commercial	132	291	159	120%
Transportation	229	297	68	30%
Mining*	--	82	--	--
Waste Disposal*	--	15	--	--
Recreation*	--	276	--	--
Total developed land	3,042	4,424	1,382	45%
Forest	4,459	4,026	-433	-10%
Salt Wetlands	25	31	6	24%
Fresh Wetlands	293	296	3	1%
Water	78	169	91	117%
Agriculture	1,271	439	-832	-65%
Open and Public	758	541	-217	-29%
Total undeveloped land	6,884	5,502	-1382	-20%
TOTAL	9,926	9,926		

* Mining, Waste Disposal and recreation were not included in the 1951 survey.

Essex

In Essex, "developed" land uses nearly doubled from 423 to 806 acres (see Table 4-9). Residential land use increased the most with a gain of 316 acres. The 733 percent growth of commercial land was the greatest percentage growth. "Undeveloped" land uses dropped 383 acres, or four percent. The largest loss was agricultural land, which dropped by 394 acres. Open & public land, with a percentage change of 42%, was the greatest percentage decrease calculated. Land use change is also demonstrated in Figure 4-3 for some of the major land use categories.

Figure 4-3

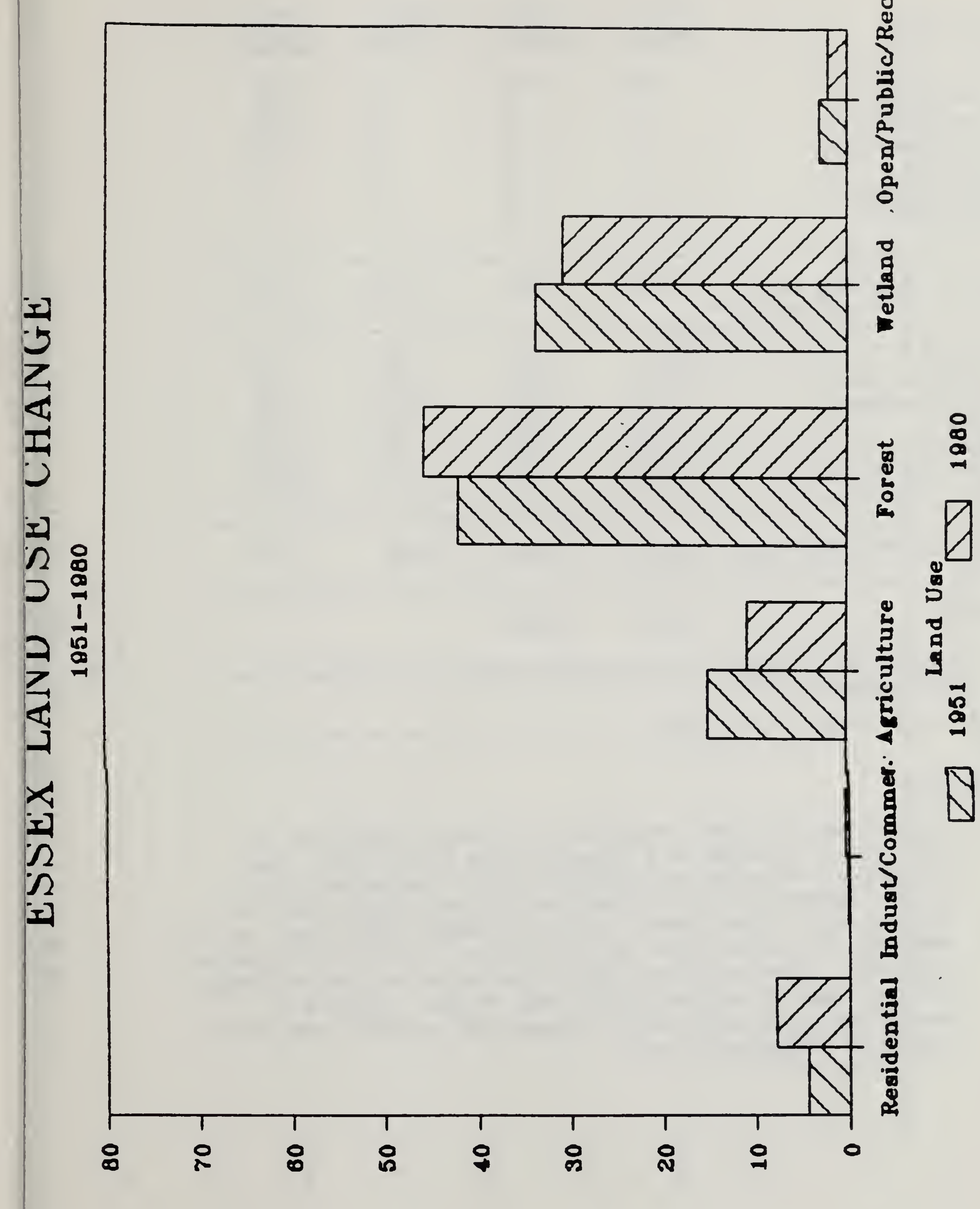

ESSEX LAND USE CHANGE
1951-1980
Percent Acreage
80
70
60
50
40
30
20
10
0
Residential
Indust/Commer.
Agriculture
Forest
Wetland
Open/Public/Rec.
Land Use
1951
1980

Table 4-9
Essex Land Use Change, 1951-1980

Land Use	1951 (acres)	1980 (acres)	Change (acres)	Percent Change
Residential	415	731	316	76%
Industrial	0	5	5	100%
Commercial	3	25	22	733%
Transportation	5	5	0	0%
Mining*	--	10	--	--
Waste Disposal*	--	5	--	--
Recreation*	--	25	--	--
Total developed land	423	806	383	91%
Forest	3,913	4,252	339	9%
Salt Wetlands	2,371	2,250	-121	-5%
Fresh Wetlands	764	612	-152	-20%
Water	202	262	60	30%
Agriculture	1,390	996	-394	-28%
Open and Public	273	158	-115	-42%
Total undeveloped land	8,913	8,530	-383	-4%
TOTAL	9,336	9,336		

* Mining, Waste Disposal and Recreation were not included in the 1951 survey.

Hamilton

Between 1951 and 1980, "developed" land uses in Hamilton more than doubled from 390 to 1,875 acres (see Table 4-10). The largest gain in acres was residential which increased 1,298 acres. Commercial land had the greatest percentage growth with 335 percent. "Undeveloped" land uses dropped 1,485 acres, or 16% percent. The largest loss was agricultural land which dropped by 719 acres. Open and public land, experienced the largest change in percentage of land use with a drop of 49%. Figure 4-4 demonstrates the relationship between 1951 and 1980 land use for the major categories of use.

Figure 4-4-

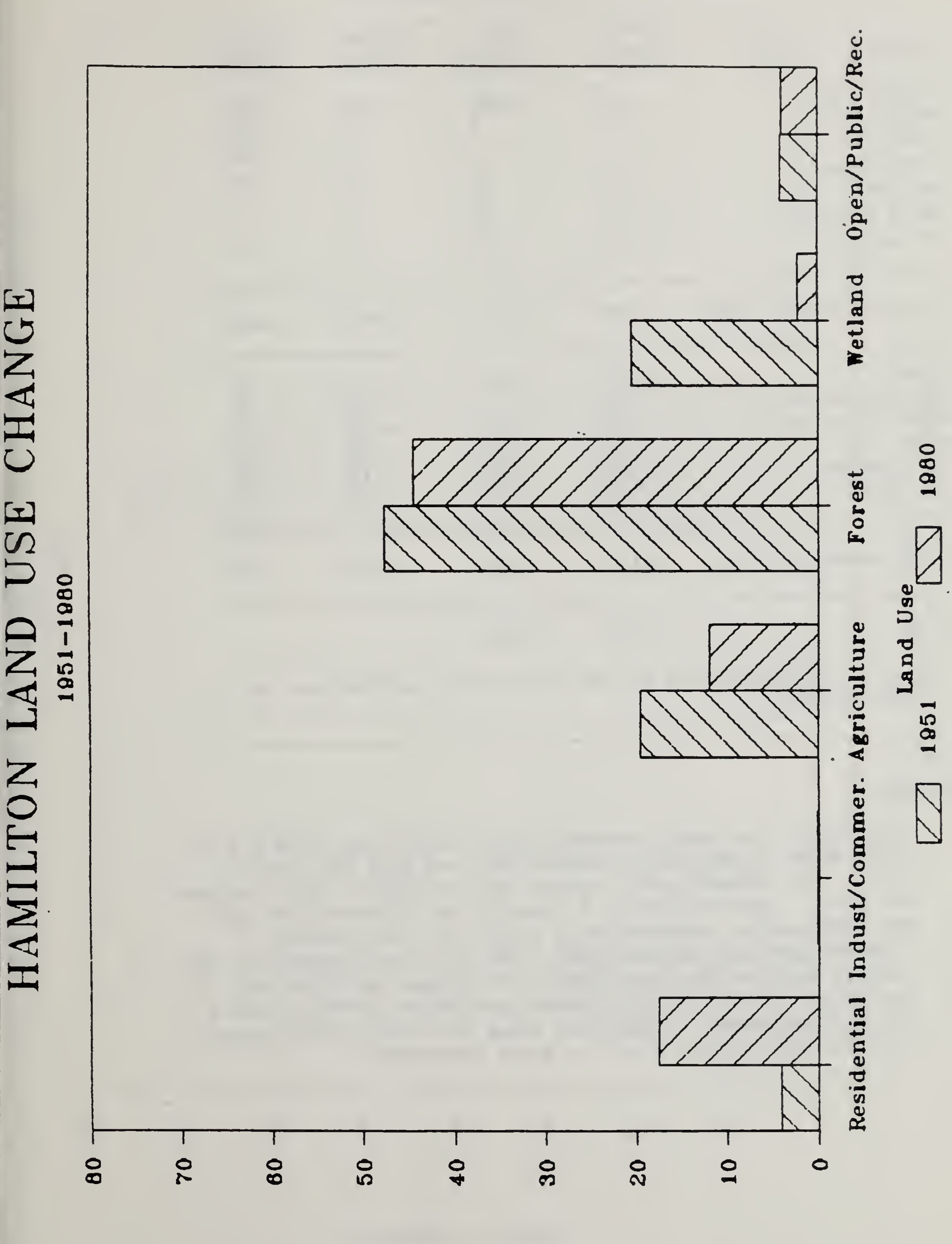

HAMILTON LAND USE CHANGE
1951-1980
Percent Acreage
80
70
60
50
40
30
20
10
0
Residential
Indust/Commer.
Agriculture
Forest
Wetland
Open/Public/Rec.
Land Use
1951
1980

Table 4-10
Hamilton Land Use Change, 1951-1980

Land Use	1951 (acres)	1980 (acres)	Change (acres)	Percent Change
Residential	387	1,685	1,298	335%
Industrial	0	0	0	0%
Commercial	3	5	2	67%
Transportation	0	0	0	0%
Mining*	--	10	--	--
Waste Disposal*	--	0	--	--
Recreation*	--	175	--	--
Total developed land	390	1,875	1,485	381%
Forest	4,543	4,239	-304	-7%
Salt Wetlands	0	0	0	0%
Fresh Wetlands	2,193	1,910	-283	-13%
Water	196	205	9	5%
Agriculture	1,869	1,150	-719	-38%
Open Space	383	195	-188	-49%
Total undeveloped land	9,184	7,699	-1,485	-16%
TOTAL	9,574	9,574		

* Mining, Waste Disposal and Recreation were not included in the 1951 survey.

Manchester

"Developed" land uses increased nearly three times from 574 to 1,698 acres in Manchester between 1951 and 1980 (see Table 4-11). The largest gain in acres was residential which increased 764 acres. Land devoted to transportation increased the most percentage-wise, experiencing a growth of 5,500 percent. "Undeveloped" land uses dropped 1,124 acres, or 25 percent. The largest loss was in forest land which dropped by 838 acres. Agricultural land had the greatest percentage decrease with a drop of 96 percent. Figure 4-5 shows the relationship between 1951 and 1980 land use for the major categories.

Figure 4-5

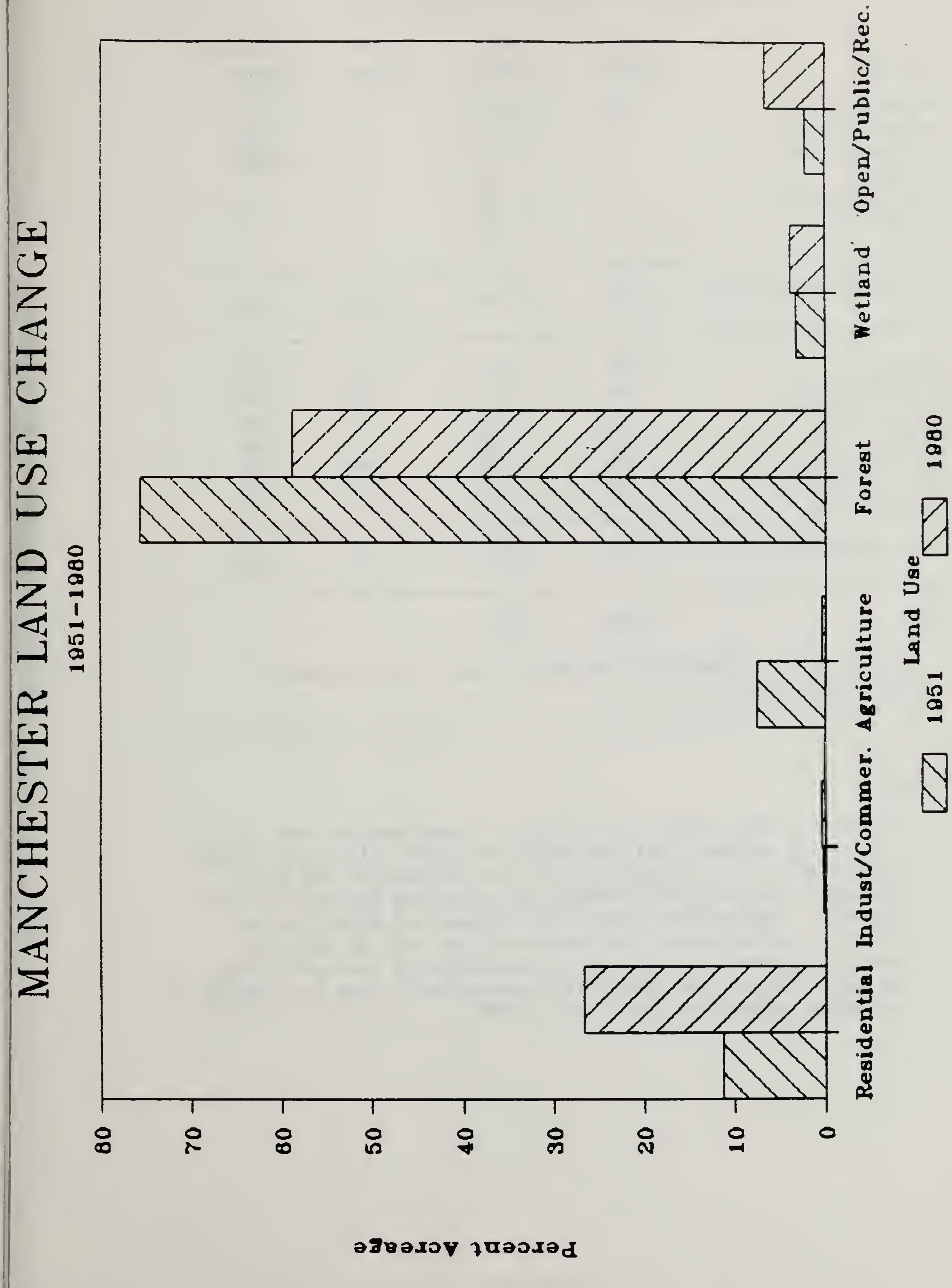

MANCHESTER LAND USE CHANGE
1951-1980
Percent Acreage
80
70
60
50
40
30
20
10
0
Residential
Indust/Commer.
Agriculture
Forest
Wetland
Open/Public/Rec.
Land Use
1951
1980

Table 4-11
Manchester Land Use Change, 1951-1980

Land Use	1951 (acres)	1980 (acres)	Change (acres)	Percent Change
Residential	563	1,327	764	136%
Commercial	9	15	6	67%
Transportation	2	112	110	5,500%
Mining*	--	46	--	--
Waste Disposal*	--	10	--	--
Recreation*	--	188	--	--
Total developed land	574	1,698	1,124	196%
Forest	3,764	2,926	-838	-22%
Salt Wetlands	46	41	-5	-11%
Fresh Wetlands	114	147	33	29%
Water	8	15	7	88%
Agriculture	374	15	-359	-96%
Open and Public	104	142	38	37%
Total undeveloped land	4,410	3,286	-1,124	-25%
TOTAL	4,984	4,984		

* Mining, Waste Disposal and Recreation were not included in the 1951 survey.

Wenham

In Wenham, "developed" land uses more than doubled from 513 to 1,176 acres between 1951 and 1980 (see Table 4-12). The largest gain in acres was residential with an increase of 525 acres. Transportation had the greatest percentage of growth with 310 percent. "Undeveloped" land uses dropped 663 acres, or 14 percent. Agricultural land decreased the most in absolute acres--616 acres--as well as in percentage of lost acres--53 percent. Figure 4-6 graphically demonstrates land use changes in the major categories from 1951 to 1980.

Figure 4-6

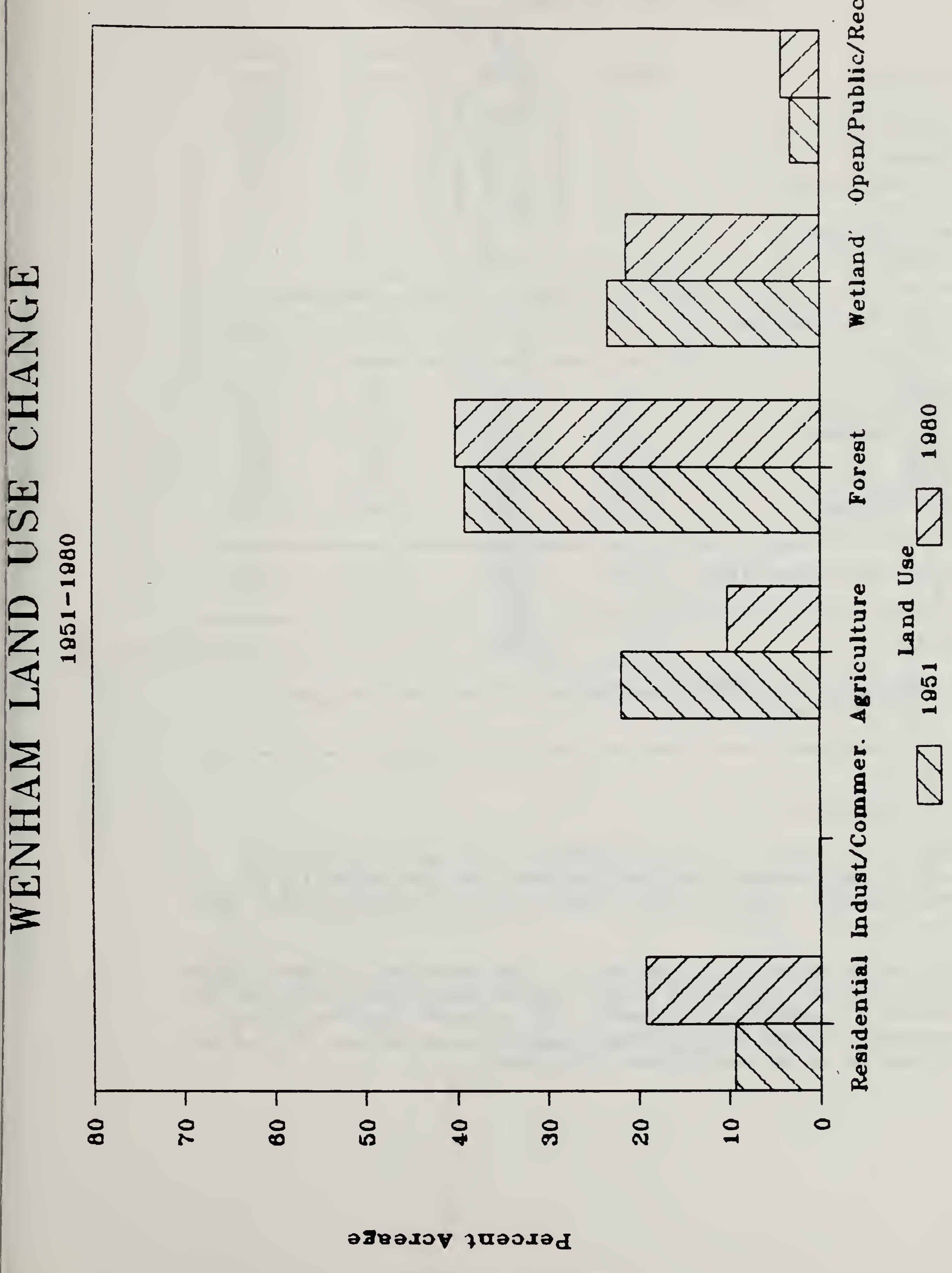

WENHAM LAND USE CHANGE
1951-1980
Percent Acreage
80
70
60
50
40
30
20
10
0
Residential
Indust/Commer.
Agriculture
Forest
Wetland
Open/Public/Rec.
Land Use
1951
1980

Table 4-12
Wenham Land Use Change, 1951-1980

Land Use	1951 (acres)	1980 (acres)	Change (acres)	Percent Change
Residential	501	1,026	525	105%
industrial	2	0	-2	-100%
Commercial	0	0	0	0%
Transportation	10	41	31	310%
Mining*	--	12	--	--
Waste Disposal*	--	0	--	--
Recreation*	--	97	--	--
Total developed land	513	1,176	663	129%
Forest	2,076	2,135	59	3%
Salt Wetlands	0	0	0	0%
Fresh Wetlands	1,240	1,135	-105	-8%
Water	163	210	47	29%
Agriculture	1,159	543	-616	-53%
Open and Public	170	122	-48	-28%
Total undeveloped land	4,808	4,145	-663	-14%
TOTAL	5,321	5,321		

* Mining, Waste Disposal and Recreation were not included in the 1951 survey.

EXISTING LAND USE

The current land use in the communities has been classified for analysis and mapped by William MacConnell of the University of Massachusetts. The following tables show the acreage of each land use category in 1980.

The entire North Shore Study Area is 25% "developed" of which 20.84% is residential (see Table 4-13). Approximately 75% of the area is currently "undeveloped," of which 45% is forest land and 16% is wetlands. Figure 4-7 shows the comparitive percentages of land use categories in the North Shore Study Area.

Figure 4-7

NORTH SHORE LAND USE BREAKDOWN

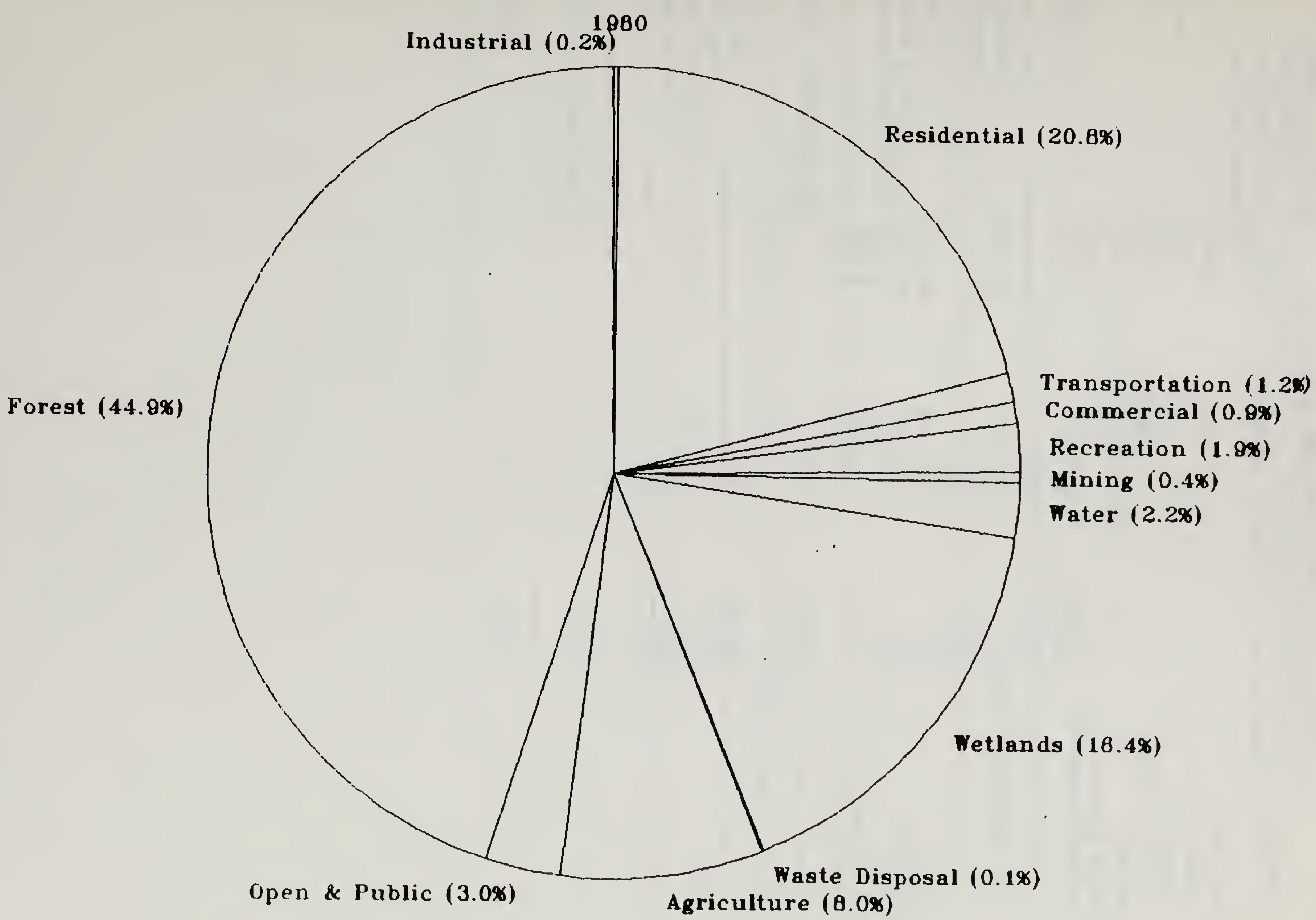


Table 4-13
North Shore Study Area Land Use, 1980

Land Use	Acres	Percent
Residential	8,156	20.84%
Industrial	81	.21%
Commercial	336	.86%
Transportation	455	1.16%
Mining	160	.41%
Waste Disposal	30	.08%
Outdoor Recreation	761	1.94%
Total developed land	9,979	25.50%
Forest	17,578	44.91%
Wetlands	6,422	16.40%
Water	861	2.20%
Agriculture	3,143	8.03%
Open and Public	1,158	2.96%
Total undeveloped land	29,162	74.50%
TOTAL	39,141	100.00%

Beverly

Beverly is 44.5% "developed", of which 34.12% is residential (see Table 4-14). About 55% of the city is "undeveloped" of which 40% is forest land. Figure 4-8 shows the comparative percentages of land use categories.

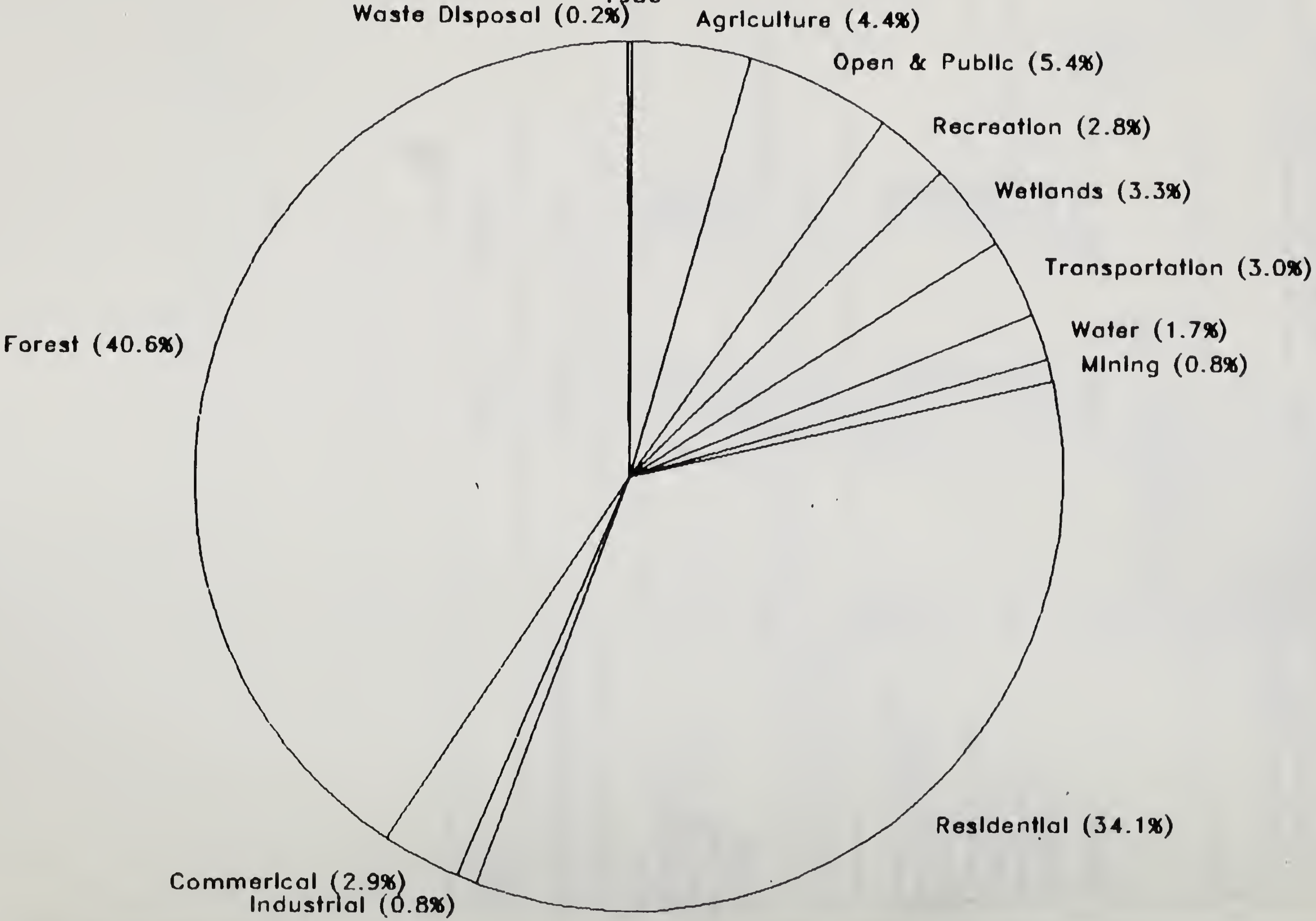
Table 4-14
Beverly Land Use, 1980

Land Use	Acres	Percent
Residential	3,387	34.12%
Industrial	76	.77%
Commercial	291	2.93%
Transportation	287	2.89%
Mining	82	.83%
Waste disposal	15	.15%
Outdoor recreation	276	2.78%
Total developed land	4,424	44.47%
Forest	4,026	40.56%
Wetlands	327	3.30%
Open and Public	541	5.45%
Agricultural	439	4.42%
Water	169	1.70%
Total undeveloped land	5,502	55.43%
TOTAL	9,926	100.00%

Figure 4-8

BEVERLY LAND USE BREAKDOWN

1980



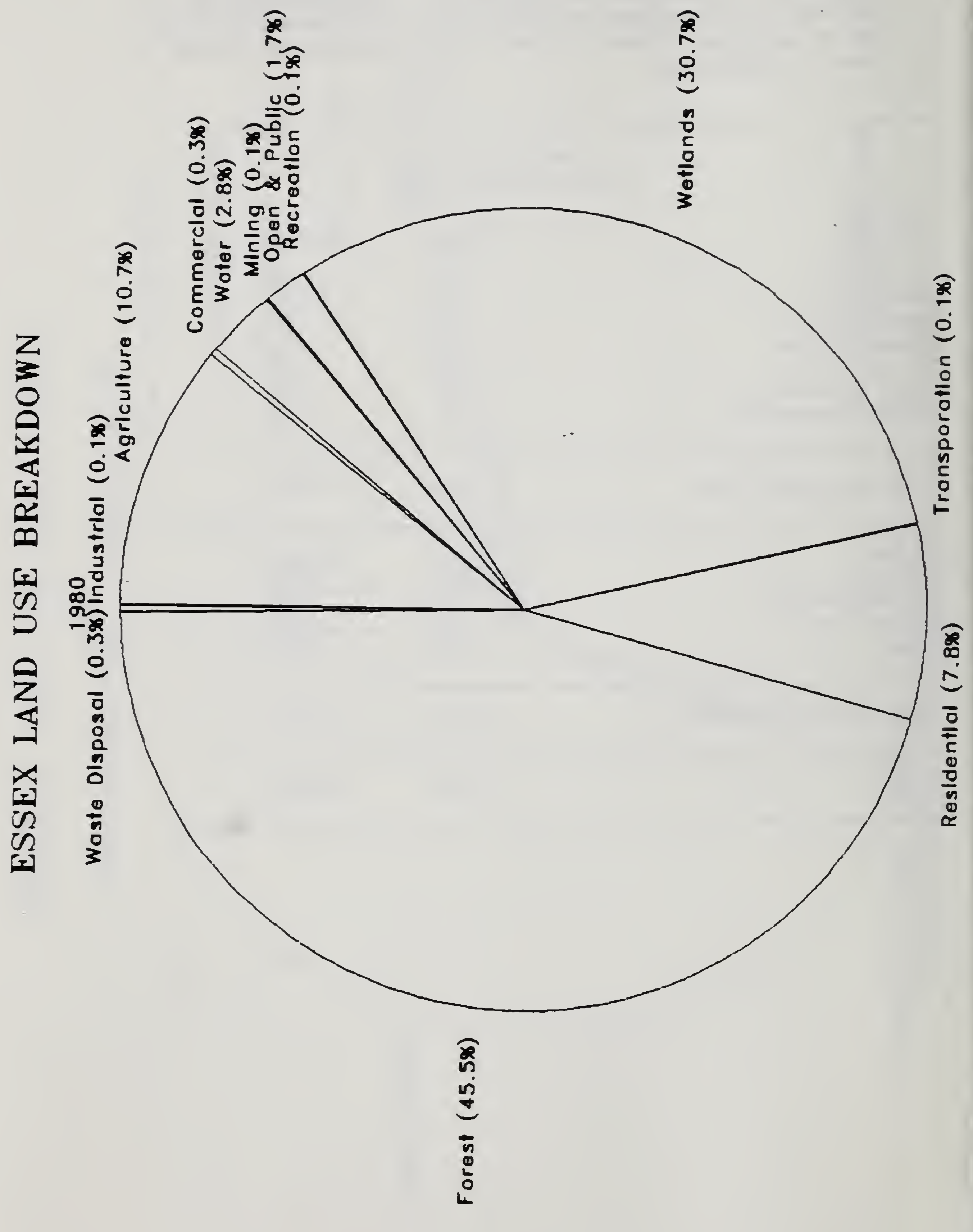
Essex

Essex is approximately 9% "developed," consisting mostly of residential development (see Table 4-15). Approximately 91% of the town is "undeveloped" of which about 45% is forest land and 30% is wetlands. Figure 4-9 shows the comparative percentages of land use categories.

Table 4-15
Essex Land Use, 1980

Land Use	Acres	Percent
Residential	731	7.83%
Industrial	5	.05%
Commercial	25	.27%
Transportation	5	.05%
Mining	10	.11%
Waste disposal	25	.27%
Outdoor recreation	5	.05%
Total developed land	806	8.63%
Forest	4,252	45.54%
Wetlands	2,862	30.66%
Open and Public	158	1.69%
Agricultural	996	10.67%
Water	262	2.81%
Total undeveloped land	8,530	91.37%
TOTAL	9,336	100.00%

Figure 4-9


ESSEX LAND USE BREAKDOWN
1980
Waste Disposal (0.3%)
Industrial (0.1%)
Agriculture (10.7%)
Commercial (0.3%)
Water (2.8%)
Mining (0.1%)
Open & Public (1.7%)
Recreation (0.1%)
Wetlands (30.7%)
Transporation (0.1%)
Residential (7.8%)
Forest (45.5%)

Hamilton

Hamilton is approximately 20% "developed," of which 17.60% is residential (see Table 4-16). About 80% of the town is "undeveloped," of which about 44% is forest land. Figure 4-10 shows the comparative percentages of land use categories.

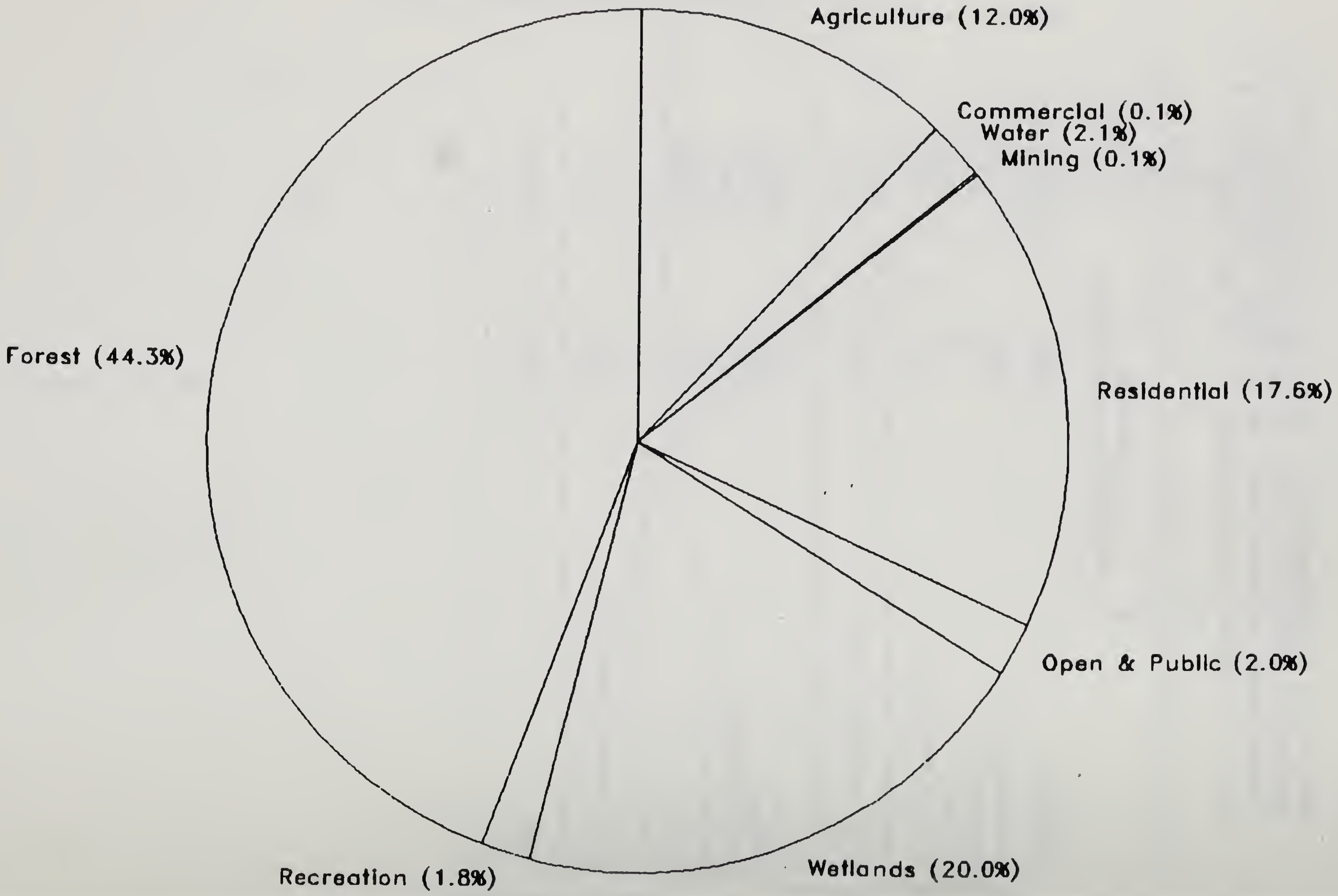
Table 4-16
Hamilton Land Use, 1980

Land Use	Acres	Percent
Residential	1,685	17.60%
Commercial	5	.05%
Mining	10	.10%
Outdoor recreation	175	1.83%
Total developed land	1,875	19.58%
Forest	4,239	44.28%
Wetlands	1,910	19.95%
Open and Public	195	2.04%
Agricultural	1,150	12.01%
Water	205	2.14%
Total undeveloped land	7,699	80.42%
TOTAL	9,574	100.00%

Figure 4-10

HAMILTON LAND USE BREAKDOWN

1980



Manchester

Manchester is 34% "developed," of which 26.6% is residential (see Table 4-17). About 66% of the town is "undeveloped" of which 58.7% is forest land. Figure 4-11 shows the comparative percentages of land use categories in Manchester.

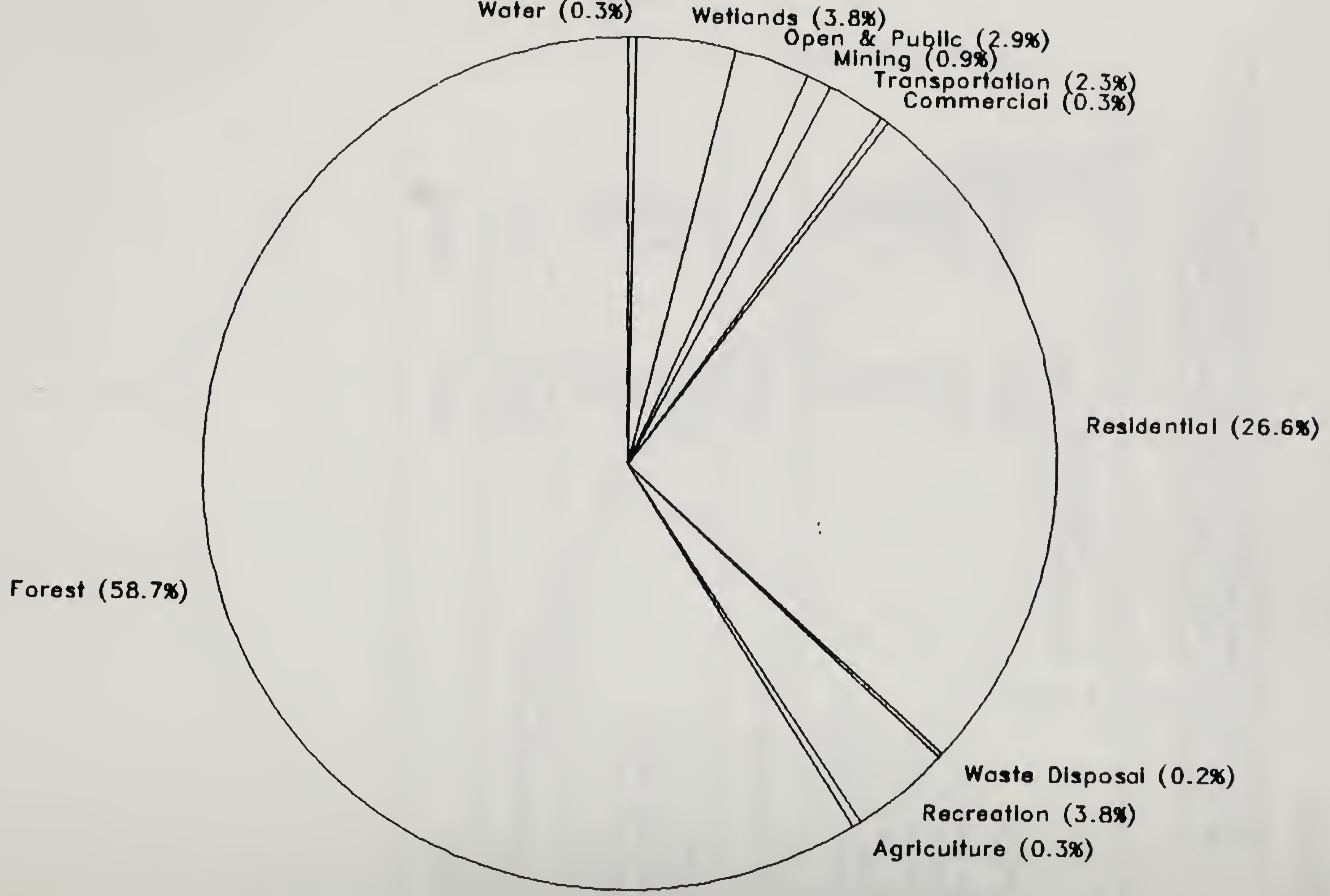
Table 4-17
Manchester Land Use, 1980

Land Use	Acres	Percent
Residential	1,327	26.63%
Commercial	15	.30%
Transportation	112	2.25%
Mining	46	.92%
Waste disposal	10	.20%
Outdoor recreation	188	3.77%
Total developed land	1,698	34.07%
Forest	2,926	58.71%
Wetlands	188	3.77%
Open and Public	142	2.85%
Agricultural	15	.30%
Water	15	.30%
Total undeveloped land	3,286	65.93%
TOTAL	4,984	100.00%

Figure 4-11

MANCHESTER LAND USE BREAKDOWN

1980



Wenham

Wenham is 22% "developed," of which 19% is residential (see Table 4-18). About 78% of the town is "undeveloped" of which 40% is forest land and 21% is wetlands. Figure 4-12 shows the comparative percentages of land use categories in Wenham.

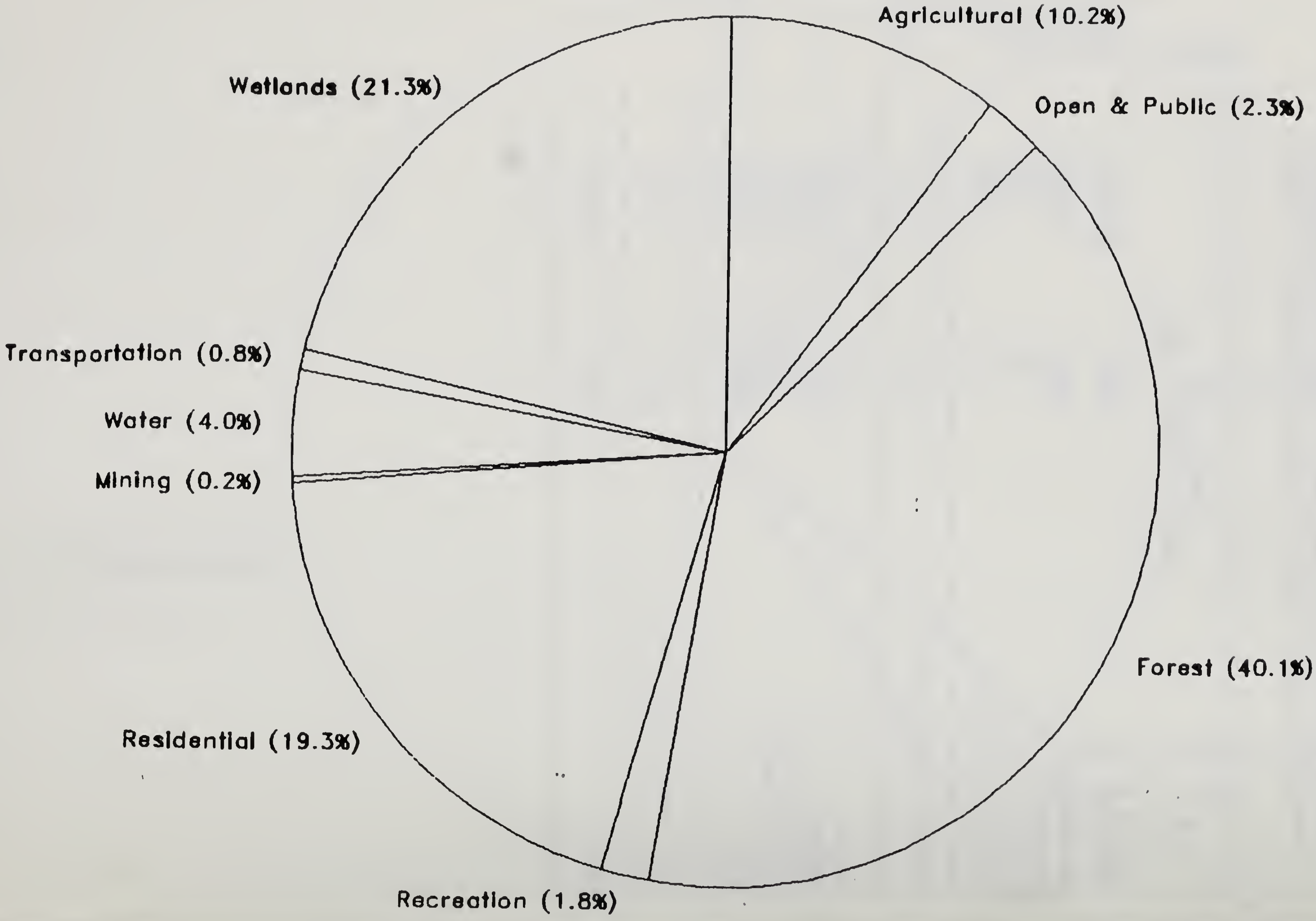
Table 4-18
Wenham Land Use, 1980

Land Use	Acres	Percent
Residential	1,026	19.28%
Transportation	41	.77%
Mining	12	.23%
Outdoor recreation	97	1.82%
Total developed land	1,176	22.10%
Forest	2,135	40.12%
Wetlands	1,135	21.33%
Open and Public	122	2.29%
Agricultural	543	10.21%
Water	210	3.95%
Total undeveloped land	4,145	77.90%
TOTAL	5,321	100.00%

Figure 4-12

WENHAM LAND USE BREAKDOWN

1980



LAND USE/WATER SUPPLY IMPACTS

Land uses within the water supply study area can affect both water quality and water quantity through physical alteration of the environment which may change drainage patterns and rates of runoff and recharge, or through discharge of contaminants to surface or groundwater (see Figure 4-13). In this section, the potential impacts of land uses on water supplies are analyzed in terms of the physical alterations and chemical contaminants associated with each. For each of these potential sources of contamination, the analysis presents:

- the characteristics and water supply impacts;
- the land uses associated with each; and
- existing conditions in the communities describing the prevalence of these land uses within the water supply study area.

The potential sources of contamination addressed are: underground fuel storage tanks, wastewater, road salt, leachate, hazardous wastes, pesticides, and mineral extraction. These potential sources are shown on Map 4.

Potential Sources of Contamination

1. Underground Storage Tanks

a. Potential Impacts. Leakage of tanks or piping that are subject to corrosion or puncturing can lead to contamination of water resources. Underground storage tank leaks are caused by a number of factors including defects in tank materials, improper installation, corrosive soils, problems with piping systems, weather conditions, or tank fatigue. Unprotected steel tanks have an average life expectancy of 15 years in corrosive soils which are characteristic of much of Massachusetts. Once tanks leak, gasoline can move through the ground and contaminate public or private wells. A small amount of fuel can contaminate large volumes of water, since concentrations as minute as several parts per billion in drinking water are considered unsafe.

b. Land Use Associations. Fuel storage is typically associated with service stations, fuel companies, auto dealerships, public facilities, bus and truck fleets, schools, churches and other institutions and residences where large underground tanks are installed for additional storage.

c. Existing Conditions. Most of the communities in the water study area maintain some records on underground fuel storage tanks. These records are the registration forms required for gasoline and diesel tanks under state and federal regulations, and oil burner permits issued by the fire departments in each community. In most cases the oil burner permits have not been updated since the burners were originally installed. These records do not reflect changes in ownership, ages of tanks, tank construction, condition of

Figure 4-13

EFFECTS OF LAND USES ON WATER SUPPLY SOURCES

LAND USE	Underground Fuel Storage Tanks	Wastewater	Road Salts	Leachate	Surface Waste Impoundments	Hazardous Waste & Materials	Pesticides/Herbicides	Fertilizers	Runoff & Erosion
	POTENTIAL DRINKING WATER CONTAMINANT								
Residential	○	●	○			○	○	●	○
Institutional	○	●	○			○	○	●	○
Commercial	●	●	○	○		●			○
Industrial	●	●	○	○	○	●			○
Agriculture	○	●				○	●	●	○
Transportation/Utilities	○		●			○	●		○
Waste Disposal/Mining	●			●	○	●			○

● Probable relationship

○ Possible relationship

tanks, or whether or not the tanks still exist. One town does not maintain records on fuel oil tanks at all.

In the five-community study area, there are 52 licensed underground gasoline and diesel storage tanks. The total volume of storage in these tanks is over 275,000 gallons. Of this total volume, nearly one-third, or about 88,000 gallons, is stored in steel tanks greater than 15 years old (see Table 4-19 & 4-20).

Table 4-19
Gasoline Storage Licenses in North Shore Water Study Area

Age Tanks	0-1000	1001-5000	5000+	Total
0-5	0	5	5	10
6-10	0	1	0	1
11-15	2	3	7	12
16-20	2	4	3	9
20+	1	4	3	8
Unknown	0	7	5	12
TOTAL	5	24	23	52

Table 4-20
Summary of Underground Storage Tanks by Community

Community	# Gas Tanks	Volume Gas Tanks	% Over 15 Years	# Fuel Oil Tanks	Volume Fuel Oil Tanks
Beverly	27	158,310	22%	111	109,575
Essex	6	20,000	67%	no records kept	
Hamilton	3	18,000	0%	15	68,050
Manchester	10	49,000	60%	26	49,450
Wenham	6	31,000	17%	14	31,000
TOTAL	52	276,310	32%	166	258,075

There are 166 underground fuel oil storage tanks in Beverly, Hamilton, Manchester and Wenham (Essex does not have registration data for these tanks). The total volume in the known fuel oil tanks is 258,075 gallons.

The combined total of known gasoline and fuel oil tanks in the study area is 218 tanks, which have a total volume of 534,385 gallons.

It is important to note that none of the communities in the water study area maintain records on underground storage facilities used for hazardous materials or chemicals. These substances can also leak into and destroy water supplies if not properly monitored and contained.

Below is a summary of the existing conditions of underground fuel storage tanks in the five North Shore Water Study communities. The collection of data presented was obtained from records on fuel tank registration located on file with the Fire Department in each community, and not through direct field counts. Therefore, it should be recognized that the presentation of data in this report is only as accurate as the record keeping conducted by each community. Given that some communities may be more diligent in the enforcement of fuel storage tank registration and its affiliated filing system, communities that appear to have more tanks and ensuing problems, in actuality, may simply be more cognizant of existing conditions. Thus, any comparative synthesis of this data between communities should take into account the above-mentioned limitation.

Beverly

There are 11 facilities licensed to store gasoline in the water study area of Beverly (see Table 4-21). Nearly 158,310 gallons of gasoline are being stored in 27 tanks at these sites. Six of these tanks are known to be over 15 years old and the ages of ten of the tanks are currently unknown (Table 4-22).

Table 4-21
Beverly Gasoline Storage Licenses
In Water Study Area

Name Address	Tank Size (gallons)	Tank Type	Installation Date	Tank Protection
Beverly Airport Comm. Beverly Municipal Airport, East Side	5,000		?	?
B.P. Oil Inc.	10,000	Fiberglass	1986	None
38 Enon Street	10,000	Fiberglass	1986	None
	10,000	Fiberglass	1986	None
Casco Chemical L.P. Henderson Rd.	5,000	?	1986	?
DPW Robinson Road	300	Steel	1974	?
GTE Sylvania	10,000	Steel	1956	None
L.P. Henderson Rd.	10,000	Steel	1960	None

Omni Aviation, Inc.	2,000		?	?
Beverly Municipal Airport, West Side	3,000		?	?
North Atlantic Air, Inc.	10,000		?	?
Beverly Municipal	10,000		?	?
Airport, West Side	6,500		?	?
	6,500		?	?
Revere Aviation	5,000	Steel	1963	Epoxy
L.P. Henderson Rd.	5,000	Steel	1963	None
	5,000	Steel	1963	None
	10,000	Steel	1970	None
Salem & Bev Water Supply	7,500	?	?	?
50 Arlington Ave.	2,500	Steel	1977	?
	2,510	?	?	?
	1,500	?	?	?
Salem Pumping Station	2,000	Fiberglass	1986	Epoxy
Salem Road				
Sunoco	1,000	Steel	1972	None
44 Enon Street	6,000	Steel	1972	None
	6,000	Steel	1972	None
	6,000	Steel	1972	None

Table 4-22
Summary of Beverly Gasoline and Diesel Tanks In Water Study Area

Age Tanks	0-1,000	1,001-5,000	5,000+	Total
0-5	0	2	3	5
6-10	0	1	0	1
11-15	2	0	3	5
16-20	0	0	0	0
20+	0	3	3	6
Unknown	0	5	5	10
Total	2	11	14	27

There are 111 underground fuel oil tanks with a total volume of 109,575 gallons registered in Beverly's water study area (see Appendix A). These are mostly home heating oil tanks under 1,000 gallons capacity, however, there are 18 tanks over 1,000 gallons. The records do not indicate the ages of these tanks, but in other communities, many residential underground tanks were installed during the energy crisis of the early 1970's. Most of the tanks installed then are approaching 15 years, the age at which unprotected steel tanks are at risk of leaking. Almost all of these tanks are unprotected steel.

The total volume of gasoline/diesel and fuel oil stored underground in the water study area of Beverly is approximately 267,885 gallons.

Essex

There are two facilities storing gasoline in the watershed area of Essex. These facilities are a gasoline station/car repair shop and a steel works shop. There are six known underground storage tanks at these sites, four of which are 15 years of age or older (see Tables 4-23 and 4-24). There are probably a number of underground fuel oil storage tanks in the watershed area, but these are currently not registered and their location is unknown. The total known volume of gasoline and diesel stored in the watershed is 20,000 gallons.

Table 4-23
Essex Gasoline Storage Licenses
In Water Study Area

Name Address	Tank Size (gallons)	Tank Type	Installation Date	Tank Protection
Quinn Brothers	3,000	Steel	1981	Painted
R 239 Western Avenue	2,000	Steel	1981	Painted
Wheel Works, Inc.	5,000	Steel	1971	Painted
152 Western Avenue	4,000	Steel	1971	Painted
	5,000	Steel	1971	Painted
	1,000	Steel	1961	None

Table 4-24
Summary of Essex Gasoline and Diesel Tanks In Water Study Area

Age Tanks	0-1,000	1,001-5,000	5,000+	Total
0-5	0	2	0	2
6-10	0	0	0	0
11-15	0	0	0	0
16-20	0	3	0	3
20+	1	0	0	1
Unknown	0	0	0	0
Total	1	5	0	6

Hamilton

There is one facility storing gasoline and diesel in the water study area of Hamilton, (see Table 4-25). There are three known underground storage tanks on this site, all three are more than ten years old (see Table 4-26). The total amount of gasoline and diesel stored in the study area is approximately 18,000 gallons.

Residences, institutions, and small businesses are storing fuel oil in 15 underground tanks throughout the study area (see Appendix A). The total volume of fuel oil stored underground in the study area is approximately 68,050 gallons. The records do not indicate the ages of these tanks, but many are likely to be at least 15 years old. Almost all of them are unprotected steel tanks.

The combined amounts of fuel oil and gasoline stored underground in Hamilton are approximately 86,050 gallons.

Table 4-25
Hamilton Gasoline Storage Licenses In Water Study Area

Name Address	Tank Size (gallons)	Tank Type	Installation Date	Tank Protection
Highland St. Sunoco	6,000	Steel	1976	Painted
203 Highland	6,000	Steel	1976	Painted
	6,000	Steel	1976	Painted

Table 4-26
Summary of Hamilton Gasoline and Diesel Tanks In Water Study Area

Age Tanks	0-1,000	1,001-5,000	5,000+	Total
0-5	0	0	0	0
6-10	0	0	0	0
11-15	0	0	3	3
16-20	0	0	0	0
20+	0	0	0	0
Unknown	0	0	0	0
Total	0	0	3	3

Manchester

There are four facilities storing gasoline in the study area in Manchester. There are 10 known underground storage tanks, six of which are 15 years of age or older (see Tables 4-27 & 4-28).

Residences, institutions and small businesses are storing fuel oil in 26 underground storages tanks in the watershed area (see Appendix A). Half of these are over 1,000 gallons. The records do not indicate the ages of these tanks, but according to tank installation trends in other communities, many are likely to be more than 15 years old. Most of them are unprotected steel tanks.

The total volume of fuel stored in the watershed is about 98,450 gallons, which includes 49,000 gallons of gasoline and 49,450 gallons of fuel oil.

Table 4-27
Manchester Gasoline Storage Licenses

Name Address	Tank Size (gallons)	Tank Type	Installation Date	Tank Protection
Doucette Contracting	3,000	Steel	1973	Painted
9 Morse Court	3,000	Steel	1973	Painted
Essex County Club School Street	3,000	Steel	1971	Painted
Massachusetts D.P.W.	8,000	Steel	1973	Painted
District 5, Pine St.	5,000	Steel	1973	Painted

Mobil Oil Corporation 96 Summer Street	6,000	Steel	1969	Painted
	12,000	Steel	1969	Painted
	8,000	Steel	1969	painted
	500	Steel	1969	Painted
	500	Steel	1969	Painted

Table 4-28
Summary of Manchester Gasoline and Diesel Tanks
In Water Study Area

Age Tanks	0-1,000	1,001-5,000	5,000+	Total
0-5	0	0	0	0
6-10	0	0	0	0
11-15	0	3	1	4
16-20	2	1	3	6
20+	0	0	0	0
Unknown	0	0	0	0
Total	2	4	4	10

Wenham

There are three facilities storing gasoline in the aquifer area of Wenham. The total volume of gas and diesel stored in the town is approximately 31,000 gallons. There are six known underground storage tanks at these sites, one of which is over fifteen years of age (see Tables 4-29 & 4-30).

There are fourteen known underground fuel oil tanks (see Appendix A). The total volume of fuel oil stored underground in Wenham is approximately 31,000 gallons. The combined amounts of fuel oil and gasoline stored underground in Wenham are approximately 62,000 gallons.

Table 4-29
Wenham Gasoline Storage Licenses
In Water Study Area

Name Address	Tank Size (gallons)	Tank Type	Installation Date	Tank Protection
Town of Wenham 138 Main Street	10,000	Fiberglass	1983	Epoxy & reinforced
	10,000	Fiberglass	1983	"

Town of Wenham 91 Grapevine Road	3,000 2,000 4,000	Steel Steel Fiberglass	1975 1961 1987	Painted Painted Epoxy & reinforced
JBNJ Realty Trust 70 Topsfield Road	2,000	?	1974	?

Table 4-30
Summary - Wenham Gasoline and Diesel Tanks
In Water Study Area

Age Tanks	0-1,000	1,001-5,000	5,000+	Total
0-5	0	1	2	3
6-10	0	0	0	0
11-15	0	0	0	0
16-20	0	0	0	0
20+	0	1	0	1
Unknown	0	2	0	2
Total	0	4	2	6

2. Wastewater

a. Potential Impacts. Both surface water and groundwater supplies can be affected by problems associated with disposal of sanitary wastes. Failing septic systems can be caused by improper siting, installation or maintenance. Soil type, depth to bedrock and depth to the water table can be major factors in septic system failure. Such failures can introduce excessive nutrients, chlorides, bacteria and household chemicals into soil that can then leach into water supplies. According to DEQE, septic systems on lots less than 40,000 square feet in area have the potential to contaminate groundwater.

b. Land Use Associations. Residential, commercial, and industrial land uses generate wastewater.

c. Existing Conditions. The water resources area in the North Shore contains some sections that are sewered, such as portions of Beverly and Manchester, but for the most part, the region relies solely on septic systems to treat sanitary wastes (see Map 5). There are two facilities discharging to groundwater in the area. Gordon Conwell Seminary in Hamilton operates its own treatment plant, and the Essex Housing Authority in Essex also treats its own sewage.

There is an area in the region where conditions may pose a threat to water quality. Chebacco Lake, Beck Pond, Round

Pond and Coy Pond have become increasingly choked with weeds in recent years which can be indicative of nutrient loading. This condition may be attributed to the introduction of human wastes from improperly placed or malfunctioning septic systems. The area around the lake and ponds is very congested with what had once been summer cottages that are now year-round residences.

Beverly

Beverly is 95% sewered and 5% unsewered. The unsewered areas are two small areas of Beverly, one of which is located in the water study area. In the northwestern corner of Beverly, the Beverly Airport and nearby residences rely on individual septic systems. Due to the location of Airport Brook, a tributary to Wenham Lake, careful maintenance and monitoring of septic systems in this vicinity is especially crucial.

Essex

The entire watershed area is unsewered and therefore, relies solely on septic systems to treat sanitary wastes. Consequently, the town's major concern relative to septic systems is that these systems be installed, operated and maintained properly. As the town wells are situated in close proximity to Chebacco Lake and on the outflow side of the lake, the condition of this lake, as mentioned above, is of concern to water quality. The shores of the lake have become closely packed with year-round residences with lot sizes often under 10,000 square feet. The entire area is very wet and marshy and therefore unsatisfactory for septic systems.

There is one wastewater discharge with an NPDES discharge permit in Essex. The Essex Housing Authority operates a small facility whose permit presently contains no effluent data. This facility is outside of the water study area. There are no groundwater discharge permits in Essex.

Hamilton

The entire Town of Hamilton is unsewered, except for Gordon Conwell Seminary which has its own treatment plant. Therefore, the aquifer recharge area relies heavily on septic systems to treat sanitary wastes. Consequently, the town's major concern relative to septic systems is that these systems be properly installed, operated and maintained. Some areas of concern to the town are around lakes and ponds in the southeast corner of the town. Hamilton and Essex share Chebacco Lake, and as mentioned above in the North Shore summary, the quality of the lake has declined in recent years.

Manchester

Approximately 40% of Manchester is sewered while 60% of Manchester's wastewater is managed by septic systems. The sewered sections of town are bordered to the west by Pine Street including most side streets, to the east by Summer Street, on the south by the harbor, and to the north by Essex Road and Hidden Ledge Road. The system is tied into a treatment plant on the harbor behind the Town Hall and the outfall is through a 14" pipe out to the ocean. The area immediately surrounding the Manchester water supply well is both sewered and unsewered with most of the large private homes around the golf course being unsewered. According to the Health Agent, the only chronic problem septic areas are along Raymond Street. This is a low, marshy, sandy area along the east border of town and lies outside of the Sawmill Brook watershed.

Wenham

The entire aquifer recharge area is unsewered except for Gordon College which is tied into Beverly's sewer system. Therefore, the recharge area relies mainly on septic systems to treat sanitary wastes. Consequently, the town's major concern relative to septic systems is that they are properly installed, operated and maintained. In the area immediately surrounding the wells at Pleasant Pond are permanent residences and some seasonal summer camps with lot sizes of 40,000 square feet or more. There are no reported chronic septic system problem areas around the Pond.

3. Road Salt

a. Potential Impacts. Deicing chemicals such as sodium chloride applied to roads in winter or stored in uncovered piles can wash off pavements into surface water bodies or percolate through soils to groundwaters. Since standard water treatment systems are unable to remove sodium from drinking water, sodium concentrations that could be harmful to the health of some individuals may result. Also, at high concentrations, sodium can corrode water distribution pipes and water fixtures. Therefore, the DEQE has set a health standard of 20 mg/l for sodium. DEQE requires regular sampling and analysis of sodium concentrations in public water supplies and notification of customers if the concentrations exceed the standard.

b. Land Use Associations. Land uses that are associated with use of road salts are transportation, for maintaining road safety in the winter, and residential, institutional, commercial, and industrial, for clearing parking lots and private drives. The Commonwealth of Massachusetts routinely treats state routes with 100% salt applied at a rate of 300 lbs. per lane mile.

c. Existing Conditions. Each community's DPW applies a different ratio of sand to salt on local roads. Salt storage, treatment practices, and sodium levels in water supply are summarized below (see Table 4-31).

Table 4-31
Road Salt Management Summary

Communities	Sodium Levels	Sand/Salt Ratio	Application Practices	Salt Storage
Beverly	15	3:1	variable, some areas pure salt, no salt applied near Wenham Lake and Longham Reservoir	Open shed outside of study area
Essex	10	19:1	all roads treated the same, no salt applied on roads leading to wells	Covered pile outside of study area
Hamilton	14	10:1	all roads treated the same, no salt applied to Pine Tree Drive leading to wells	Closed shed in water study area
Manchester	11	4:1	all roads the same	Closed shed in water study area
Wenham	15	7:1	restricted throughout town	Closed shed in water study area
STATE	--	0:1	300 lbs. per lane mile on all state roads	Closed shed in water study area of Manchester

Source: DEQE Water Quality and Local DPWs

Beverly

Sodium levels in 1987 were:

Wenham Lake	13.0 mg/l
Longham Reservoir	18.0
Putnamville Reservoir	13.0
Ipswich River	26.0
Finished Water at Plant	15.0

Although two of Beverly's sources have relatively high sodium contents, they are able to maintain levels at or below 15 mg/l in their finished water because they can regulate the mixture of water from different sources, and try to draw from those sources containing high levels of sodium only seasonally. The Ipswich River and Longham Reservoir's sodium contents peak following winter storms. Their relatively high sodium levels are attributed to road salt on state roads in their watersheds.

The City of Beverly treats most of its main roads and hills with straight salt, depending on the severity of the storm and the resulting road conditions. Secondary roads are plowed, but in most instances, not treated with salt. In 1985, the DPW purchased a calcium chloride spraying device that allows a reduced rate of sodium chloride application to achieve the same result. Beverly stores up to 400 tons of salt in a three-sided concrete shed and up to 1600 tons in a tarp-covered pile of salt/sand mixture on Park Street in back of the city DPW yard. This is outside of the water study area.

The city does have a "low-salt" application policy in two areas, both located in the water study area. One area is located in North Beverly in the watershed of Wenham Lake, affecting Cabot, Henderson, and Trask Streets. In the watershed area of Longham Reservoir, located in Centerville, reduced road salt application applies to roads located north of Route 128 and east of Grover Street to the city's border. A sand/salt mixture is applied at a ratio of 3:1. Snow dumping and salt storage do not occur in or near the water study area.

The approximately 11 miles of roads treated by the State DPW within the water study area are Route 128 and Cabot, Dodge, and Enon Streets.

Essex

1987 sodium levels in water sources were:

Harry Homan's Well #1	9.8 mg/1
Harry Homan's Well #2	8.3
Chebacco Lake	8.1
Finished water at Plant	10.0

Road salt used by the Town of Essex is stored in a pile at the DPW yard on Memorial Drive behind the Town Hall and the Fire/Police Station. The town stores approximately 35 tons, which is usually covered with polyethelene. This storage pile is outside of the watershed area along the Essex River saltmarsh. The sand to salt mixture used by the town is 19:1. There are approximately 26 miles of streets maintained by the town. The state maintains State Route 22 which runs approximately 1.5 miles through the aquifer area.

Hamilton

1987 sodium levels were:

School Street Well	22.0 mg/l
Patton Well	13.0
Caisson Well	16.0
Idlewood Well	12.0

The Caisson well must be tested quarterly because it exceeds 15 mg/l. Consumers supplied by School Street well must be notified of elevated sodium levels because it exceeds DEQE safe standards of 20 mg/l; however, School Street well is currently used for emergency summer supply only. DEQE will instruct Hamilton's water department if notification is required. Also, most of the town water is from more than one source, so the finished water will have an average sodium content for whatever sources are on line at the time.

Road salt used by the Town of Hamilton is stored in a shed behind the Town Hall, inside the study area. The town uses approximately 300 tons of salt per year. The sand to salt mixture used by the town is 10:1, however, the town doesn't use salt near the town wells on Pine Tree Drive off of Lake Drive. There are approximately 43 miles of streets maintained by the town. The state maintains Route 1A, however, Route 1A is not within the water supply study area.

Manchester

1987 sodium levels were:

Gravelly Pond	10.0 mg/l
Lincoln Street Well	13.0

Road salt used by the Town of Manchester is stored in a 40 x 60 foot salt shed near the west end of Pleasant Street, within the Sawmill Brook watershed. The state DPW also has a salt storage shed in Manchester just south of the Hamilton line on Pine Street. These piles are contained in sheds with impervious pads and drainage controls. The town uses a 4:1 sand to salt mix and maintains all local roads in the town (excluding private roads). There are approximately 35 miles of town roads and 10 miles of state roads in Manchester. The state maintains Routes 127 and 128. About 3.75 miles of Route 128 and 1.5 miles of Route 127 are within the water supply study area.

Wenham

1987 sodium levels in wells were:

Well #1	14.0 mg/l
Well #2	18.0

Well #2 is only in use during summer months. Because it exceeds 15 mg/l, it must be tested quarterly when it is on line. Water from Well #1 and Well #2 is mixed when distributed to customers so the sodium content would be somewhat averaged. Well #2 is affected by drainage from Route 1A which is salted by the state at 300 lbs. per lane mile.

Road salt used by the town of Wenham is stored in an enclosed structure behind the town garage off of Grapevine Road in the study area. The town stores approximately sixty tons in the shed, and uses between 160-250 tons of salt per year. The sand to salt mixture used by the town is 7:1. The entire town is considered salt restricted and there are signs posted at the town boundaries indicating this condition. The town has been restricting salt use for over 15 years. There are approximately thirty miles of streets maintained by the town, while the state maintains Route 1A which runs approximately 1.25 miles through Wenham.

4. Leachate

a. Potential Impacts. Leachate is liquid waste that results when water percolates through buried materials in sanitary landfills, waste impoundments, and other disposal sites. Depending on the characteristics of the buried materials, leachate can contain inorganic and organic contaminants, as well as dissolved solids that can degrade the quality of water supplies.

b. Land Use Associations. Land uses which may be associated with leachate generation are classified as waste, industrial, and commercial. Waste uses include sanitary landfills and other official dump sites.

c. Existing Conditions. There are no operating landfills in the water study area at this time. Hamilton and Manchester's landfills are monitored and test clean; Beverly's landfill is not currently monitored but tested clean when it was closed; and, Wenham's landfill is monitored down-gradient by the Salem and Beverly Water Supply Board and currently tests clean.

Beverly

Beverly hauls all of the city's solid waste to the RESCO treatment facility in Saugus. Most waste is collected through curbside pickups; however, a small amount is disposed of at a transfer station located at the site of the city's closed landfill on Brimbal Avenue. Waste deposited at the transfer station is dumped into roll-off containers and then hauled to the RESCO plant.

The Brimbal Avenue Landfill is located on Route 128 near Otis Road, just outside the watershed study area. The landfill opened in 1958 and closed in May of 1985. It has been covered with gravel, but is not fully capped as yet. The city has developed the final closure plan and is awaiting approval from DEQE. It is anticipated that completion of the capping process can be initiated in the fall of 1988. Upon approval of the closure plan, water quality monitoring wells will be drilled to allow for water quality testing. Presently, leachate collection systems are tied into the city's sewer system.

In addition, the city is aware of a private flyash dump located on Henderson Road, as well as illegal dumping activity nearby. Both are within the watershed study area. DEQE is in the process of investigating the illegal dumpsite. Officials are unsure of the materials being disposed of there, though it is known that there is fly-ash and varying solid wastes.

Essex

Essex's town landfill, located at the end of Landing Road in the Essex River saltmarsh, was closed according to DEQE standards several years ago. They currently operate a trash transfer station at the site and contract with Ogden-Martin Systems of Haverill for trash removal. The landfill tested clean at the time of closing and is not currently monitored. The dump/transfer station is outside of the water supply area. There are no known sources of leachate in the study area in Essex.

Hamilton

Hamilton's town landfill, located at the end of Chebacco Road in the Gravelly Pond watershed, was capped in 1983. The landfill is monitored and tested four times a year for leachate; it currently tests clean. However, field reconnaissance in the area showed the road leading to the landfill to be very trashy with abandoned refrigerators, tires and metal parts lying along the road and in the adjacent wetlands. Hamilton contracts with NESWC for trash removal.

Manchester

Manchester's town landfill is located at the end of Pine Street near Hamilton's border, within the Gravelly Pond watershed. It was capped in 1981 and is monitored. The landfill currently tests clean. Manchester contracts with NESWC for trash disposal.

Wenham

The town landfill, located off of Woodside Lane, was closed 15-20 years ago. It is not monitored by the town of Wenham, but this area drains towards Wenham Lake which the Salem & Beverly Water Supply Board uses as their main water source. The Supply Board carefully monitors the area down slope of the landfill for leachate and the area currently tests clean. Trash is collected and disposed of by NESWC.

5. Hazardous Wastes and Materials.

a. Potential Impacts. Hazardous wastes are wastes which are toxic, reactive, corrosive or ignitable. Improper handling of hazardous wastes is an obvious threat to drinking waters; however, federal and state regulations have been enacted to reduce the threat of contamination, including water supply contamination. A less obvious source of hazardous wastes is what is commonly referred to as "household hazardous wastes." These include materials such as bleach, mothballs, paint remover, oven cleaner, wood preservative, antifreeze, and used motor oil. If improperly disposed of, they also can reach groundwater or surface water and result in contamination of supplies. This is especially true in an unsewered area, such as most of the water supply study area. Properly operating septic systems can treat domestic sanitary wastes, but many "household hazardous wastes" disposed of in septic systems may travel unabated through the soil and enter groundwater or eventually travel to surface waters.

b. Land Use Associations. All developed land use types have the potential to be associated with hazardous wastes. Commercial and industrial uses pose a greater threat in terms of quantity but the handling of these materials is increasingly regulated by state and federal programs. Residential uses may also generate small quantities of hazardous wastes. Due to the high number of septic systems in use in the water study area, our concern is for the household hazardous wastes which may be disposed of through household septics and which can leach into water supplies. In addition, transportation corridors are susceptible to accidental spills of hazardous materials in transport.

c. Existing Conditions. Within the water study area, 1,175 acres are zoned for business and industrial uses, 2,496 acres are zoned mixed use, and 10,128 acres are zoned residential. There is a potential for hazardous materials usage and the generation of hazardous wastes with all of these land uses. There are 23 hazardous waste handlers on the 1988 RCRA list for the study area. In addition, the regulatory list may not be entirely comprehensive and may overlook smaller businesses that could be handling hazardous materials as well. Only Hamilton and Manchester have household hazardous waste collection programs.

Beverly

There are seventy-two hazardous waste handlers on DEQE's 1988 Inventory for Beverly, four of which are in the water study area (see Table 4-32). Beverly also has a facility discharging directly to groundwater under a DEQE permit. This discharge is associated with a groundwater reclamation and treatment project in response to a gasoline spill. Beverly does not have a household hazardous waste collection program. Furthermore, hazardous materials handlers are not listed at this time, but Beverly has 201 acres zoned commercial and industrial in the water study area where hazardous materials may be used.

Table 4-32
Beverly Hazardous Waste Handlers
Listed Under RCRA 1988
(Within the Water Study Area)

Name Address	Activity Type	Waste Codes*
Hogan Tire Center 137 Dodge Street, Route 1A	Generator	D001
Sams Cleaners Inc. 33 Dodge Street	Generator	F002
Tire Bargain Center 60 Dodge Street	Generator	D001
Varian Associates, Bev. Div. 8 Salem Road		D001, D002, D003, F001, F002, F003, F005, F006, F007, F008, F009, P015, P029, P030, P073, P074, P098, U013, U044, U112, U122, U134, U151, U154, U159, U165, U169, U185, U187, U210, U220, U226, U227, U239

* See Appendix B for Waste Codes Summary

Essex

There are nine hazardous waste handlers on DEQE's 1988 Inventory for Essex within the water study area (see Table 4-33). All nine are hazardous waste generators. Hazardous materials handlers are not listed at this time, but there are 2,496 acres zoned mixed use in the water study area where hazardous materials may be used.

Furthermore, motor boats are permitted on Chebacco Lake and may pose a threat to water quality by leaking gasoline and oil from the motors. Also, the materials used to maintain boats such as solvents and paints are found in abundance around the lake. Improper handling of these materials can result in contamination of drinking water supplies. Essex does not have a household hazardous materials collection program.

Table 4-33
Essex Hazardous Waste Handlers
Listed Under RCRA 1988

Name Address	Activity Type	Waste* Code
B&P Machine 245 Western Avenue	Generator	D001
Dave Hidden 204 Western Avenue	Generator	D001
Frenchies 153 Rear Western Avenue	Generator	D001, F002
Gaybrook Garage 152 Western Avenue	Generator	D001
Gullwing Service Co. Inc. 106 Western Avenue	Generator	D001
Liberty Research Co. Inc. Essex Park Road	Generator	F001
Maverick Machine Co. 246 Western Avenue	Generator	D001
Terminal Garage Inc. 16 County	Generator	D001
Varian Associates Extrion Div. 106 Western Avenue	Generator	U226

* See Appendix B for Waste Code Summary

Hamilton

There are no hazardous waste handlers on DEQE's 1988 Inventory for Hamilton and hazardous materials handlers are not listed at this time. Hamilton has no areas zoned commercial or industrial in the water study area.

Motorboats, which may pose a threat to water quality in leaking gasoline and oil from the motors, are permitted on Chebacco Lake. Also, the materials used to maintain boats such as solvents and paints are found in abundance around the lake. Improper handling or disposal of these materials can result in contamination of drinking water supplies.

Hamilton has a successful household hazardous waste collection and education program which is entering its third year. The program involves displays at the library and a movie/slide presentation sponsored by the League of Women Voters. The town has voted to include household hazardous waste collection costs in its annual budget for fiscal year 1988 and subsequent years. The town contracted with Clean Harbors for removal of collected materials.

Manchester

There are six hazardous waste handlers on DEQE's 1988 Inventory for Manchester in the water study area (see Table 4-34). All six are hazardous waste generators in small quantities. Hazardous materials handlers are not listed at this time, but there are 877 acres zoned commercial in the water study area where hazardous materials may be used.

Manchester held one household hazardous waste collection in October 1987 and the town is currently planning another collection. The town contracted Clean Harbors to handle the collected materials. Publicity and community education were handled by the League of Women Voters.

Table 4-34
Manchester Hazardous Waste Handlers
Listed Under RCRA 1988

Name Address	Activity Type	Waste Codes*
Balleys Service Station Inc. 96 Summer	Generator	D001
Bevilaqua Trucking Atwater Avenue	Generator	D001
Coastal Auto Repair Atwater Avenue	Generator	D001

Dry cleaning by Empire 15 Summer Street	Generator	F002
rchester Auto Body 6 Elm Street	Generator	D001
Seaside Auto Body 2 Pine Street	Generator	D001 & F003

* See Appendix B for waste code summary.

Wenham

There are two hazardous materials handlers on DEQE's 1988 Inventory for Wenham within the water study area (see Table 4-35). Hazardous materials handlers are not listed at this time. There are 4 acres zoned commercial in the water study where hazardous materials may be used. Wenham does not have a household hazardous waste collection program.

Table 4-35
Wenham Hazardous Waste Handlers
Listed Under RCRA 1988

Name Address	Activity Type	Waste Code*
Gordon College Physical Plant 755 Grapevine Road	Generator	D001
Tru-Form Industries Inc. 116 Topsfield Road	Generator	F001

* See Appendix B for waste code summary.

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6. Pesticides

a. Potential Impacts. The term pesticides includes insecticides, fungicides, herbicides, and rodenticides. These are all chemical compounds used to control unwanted organisms such as insects, weeds, and rodents. Since the compounds vary depending upon their target organisms, their potential effects on water resources also vary greatly. Pesticides may enter water supplies by direct infiltration through the ground or by way of runoff. Impacts on water supplies may be caused by improper use, storage or disposal of pesticide products. In some locations, even properly regulated applications may have the potential to contaminate water supplies.

b. Land Use Associations. Land uses associated with pesticide application include residential, institutional, transportational, utility (electrical), agricultural, and recreational. For instance, homeowners use pesticides to control insects, weeds, and rodents in gardens and homes.

Municipal departments of public works often use herbicides and fungicides to maintain landscaped areas. County mosquito control programs apply larvicides directly to surface water bodies and spray adulticides weekly during summer months to control mosquitos.

Utility companies use selective herbicide applications to eliminate tall-growing trees that interfere with the function of the utility lines. The general amount of herbicide used for this is less than one gallon per acre. Under new state regulations, however, no folier application of herbicides is allowed to control vegetation greater than 12 feet in height, except for side trimming.

The intent of railroad herbicide applications is to control all vegetation along the track since plant overgrowth may cause degradation of the track or lead to fires. In most cases, the area treated extends about 12 feet to either side of the center of the track, known as the railroad layout or ballast area. [Note: In those areas set within 100 feet of a wetland, state regulations restrict herbicide application within 10 feet of the wetland and beyond 9 feet of the centerline of the track.] A number of chemicals are used together that generally amount to 5 to 8 gallons of herbicide per acre.

Water-soluble herbicides may be used directly in standing water bodies for control of aquatic plants under a permit from the DEQE, Division of Waterways. These compounds also may reach water bodies by accidental drift from equipment cleanup after application.

c. Existing Conditions.

Beverly

The only active right-of-way through Beverly is the Boston & Maine Railroad which is maintained as noted above. However, the right-of-way does not pass through the water study area. Beverly is a member of the Essex County Mosquito Control Program. Essex County applies the pesticides noted above and further controls mosquitos through source elimination under a water management program. In addition, there are approximately 46 acres of agriculture crop land and orchards in the water study area of Beverly, that may be subject to pesticide application.

Essex

The only active utility right-of-way through Essex is a gas pipeline owned and maintained by Tenneco Inc.

According to a representative of the company, this easement is hand-cut and mowed; no herbicides are used. There are approximately 636 acres of agricultural crop land and orchards in the water study area of Essex that may be subject to pesticide application. Essex is not a member of the Essex County mosquito control program.

Hamilton

Hamilton has several right-of-ways through the town. They are Boston & Maine Railroad and a gas pipeline owned and maintained by Tenneco, Inc. Boston & Maine clears its tracks utilizing the standard methods noted above. However, the railroad does not run through the water supply study area. As noted for Essex, Tenneco's easement is hand-cut and mowed and no herbicides are applied. Hamilton is a member of the Essex County Mosquito Control Program. Essex County utilizes the larvicides and adulticides mentioned above, in addition to source elimination through a water management program. There are approximately 238 acres of agriculture crop land and orchards in the aquifer area of Hamilton that may be subject to pesticide application.

Manchester

The Boston and Maine Railroad runs through Manchester and is maintained as noted above. About one mile of the right-of-way runs through the Sawmill Brook watershed, down gradient from the Lincoln Street well.

Manchester has a private country club called the Essex County Club. This club is in the immediate vicinity of the well and in fact, Green #7 is less than 200 yards from the well. However, the greenskeeper is well aware of potential impacts to water supply from herbicides, fungicides and fertilizers. The club currently treats greens and collars with fungicides and insecticides while fairways and greens are treated with fertilizers. Only those quantities necessary to maintain a playable surface are applied. The greens are treated approximately four times a year with fungicides and two times a year with insecticides. The club owns about 180 acres, 160 of which are golf course. Of that 160 acres, 60 are maintained as golf greens and fairways; the remainder is wooded.

It is important to note that though the club is closest to the wells, there are many large manicured lawns upstream from the wells on Sawmill Brook. Unlike the professional greenskeeper, homeowners may not [illegible] well-informed to ensure proper application of pesticides.

Manchester belongs to the Essex County Mosquito Control Program, but does not participate in the larvicide and adulticide applications. The County controls mosquitos in Manchester's marshes by source elimination through a water management program. Manchester also has about four acres of agriculture crop land and orchard that may be subject to pesticide application.

Wenham

Active right-of-ways through Wenham are a gas pipeline owned and maintained by Tenneco Inc. and Boston & Maine Railroad. As mentioned above, the Tenneco easement is hand-cut and mowed, and the company does not use herbicides. The railroad is maintained as noted above. There are approximately 183 acres of agricultural crop land and orchards in the aquifer areas of Wenham that may be subject to pesticide application. Wenham is not a member of the Essex County Mosquito Control Program. The town voted years ago to exclude themselves from this pesticide spray program.

7. Mining

a. Characteristics and Water Supply Impacts. Sand and gravel is considered New England's most valuable mineral resource. As much as 90% of Massachusett's groundwater aquifers are found in areas containing sand and gravel deposits. Mining in these areas may cause adverse impacts to the quality and quantity of groundwater supplies. Removal of earth material above a water table reduces the degree of filtration of precipitation and runoff before the recharge waters reach the aquifer. Also, uses associated with mining, such as sand/salt mixing and gasoline and oil storage to maintain mining equipment can also threaten groundwater.

The quantity of recharge may also be diminished due to sand and gravel operations. Excavation may inhibit the downward flow or percolation of recharge waters by altering slopes, compaction, or altering drainage patterns. Increased evapotranspiration may occur if enough earth material is removed such that plant roots can reach the groundwater. Therefore, sand and gravel operations should be regulated properly to protect against the degradation of groundwater resources. Mining poses a threat to groundwater if the excavation reaches too close to the water table, not leaving a sufficient buffer zone for contaminants to be filtred out. Future land uses on abandoned mines should also be carefully regulated, considering the potential groundwater impacts.

b. Land Use Associations. Mining; sand and gravel excavation.

c. Existing Conditions. There are no active sand and gravel operations in the water supply area, although Manchester has an industrial site preparation that involves excavation on the north border of the town.

Beverly

No known mining or sand and gravel excavation activity is ongoing in Beverly.

Essex

In the watershed area north of County Road there is a sand and gravel pit, but it was never mined extensively and not to the water table. It is currently closed.

Hamilton

There is one gravel pit off of Cutler Road just north of the Boston & Maine Railroad. The pit was operated by Carter Stables. It has never been excavated below the water table and the pit is not currently mined. This site is outside of the water supply study area.

Manchester

There is one excavation site being operated in Manchester as an industrial site preparation near Route 128 behind the Tennis Club. This is a 15 acre plot that will be taken down to road grade and should not directly impact groundwater. In addition, there are a series of abandoned gravel pits in the west end of town along Route 128. These were used during construction of Route 128 and have since been used as illegal dumps. The town has erected gates at the Beverly entrance to the pits. The present condition of the pits is unknown.

Wenham

Wenham has no sand and gravel pits or mining operations.

CHAPTER 5

ZONING AND REGULATION OF LAND USE

The preceding chapter focused on land uses that have potential impacts on water supplies. This chapter summarizes existing local, state, and federal laws and regulations that control those land uses. The zoning bylaws and ordinances for each municipality also are examined in an effort to assess the potential impacts of future development, and their compatibility with water supply protection. This regulatory analysis will form the basis of the recommendations made in the next chapter.

EXISTING REGULATIONS

A host of local, state, and federal laws and regulations currently exist which regulate the land uses identified in the preceding chapter as having potential water quality impacts. These laws and regulations are summarized in Figure 5-1 and described below.

Underground Storage Tanks

- Federal. EPA is developing new requirements that will set minimum standards for state regulations of underground fuel storage. There are no federal regulations for underground storage of hazardous materials.

- State. The Board of Fire Prevention Regulations has issued new regulations for underground storage of fuel which require: (527 CMR 9.00)

    - tank registration
    - inventory control
    - non-corrosive tanks
    - periodic tank testing
    - removal of abandoned tanks

    Residential and farm gasoline tanks less than 1,100 gallons, as well as heating oil tanks connected to burning equipment, are exempt from these regulations. For these kinds of tanks, there are few measures to prevent tank contents from contaminating water supplies if a leak should occur. There are no state regulations controlling underground storage of hazardous materials.

- Local.

    Beverly. There are no city ordinances governing underground storage. However, in the Watershed Protection Overlay District, underground fuel storage tanks are either vaulted (75%) or have a double-walled monitoring system (25%). The Beverly Fire Prevention Office licenses fuel oil tanks with a capacity of 10,000 gallons or less and gasoline storage tanks with a capacity of 300 gallons or less. The Beverly Board

Figure 5-1

POTENTIAL IMPACTS AND MANAGEMENT TECHNIQUES

REGULATIONS	Underground Tanks	Wastewater	Road Salt	Leachate	Hazardous Wastes & Materials	Pesticides	Mining	Runoff & Erosion & Recharge
	POTENTIAL SOURCES OF CONTAMINATION							
FEDERAL								
Resource Conservation & Recovery Act (RCRA)					●			
Federal Safe Drinking Water Act		●						
Superfund Amendments & Reauthorization Act (SARA)					●			
STATE								
Fire Prevention Regulations	●							
DEQE Solid Waste Regulations				●				
Hazardous Waste Management Act					●			
Pesticide Control Act						●		
Groundwater Discharge Regulations		●						
NPDES Surface Water Discharge Permits		●						
State Environmental Code (Title 5)		●						
Landfill Regulations				●				
LOCAL								
Water Resources Protection Overlay District	bh							
Board of Health - Title 5 Supplements	behm							
Wetlands Protection District					h			
Underground Storage Tank Bylaw/Regulations								
Earth Removal Regulations								
Household Hazardous Waste Collection Program					hm			
Hazardous Materials Bylaw								
Road Salt Storage/Controlled Application Program			w					
Subdivision Regulation Amendment		bh						
Landfill Regulations				eh				

b	Beverly
e	Essex
h	Hamilton
m	Manchester
w	Wenham

of Aldermen licenses fuel oil tanks exceeding 10,000 gallons and gasoline storage tanks exceeding 300 gallons.

Essex. There are no local controls of underground fuel or hazardous materials storage.

Hamilton. In 1987, Hamilton adopted an amendment to its Groundwater Protection District zoning bylaw which prohibits new underground installations of "tanks used for storing heating oil for consumptive use on the premises where stored," and "farm or residential tanks of 1,100 gallon capacity or less, used for storing motor oil/fuel for non-commercial purposes." The intent of this measure is to restrict new installations of those tanks which are exempted by the state regulations. This bylaw also provides for installation specifications on above ground and in-building tanks and on underground piping to prevent hazards to soil and water from leaks. This bylaw is specific to the Groundwater Protection District.

Manchester. There are no local controls of underground fuel or hazardous materials storage.

Wenham. There are no local controls of underground fuel or hazardous materials storage.

Wastewater

- Federal. Industrial and sanitary wastewater discharges to surface waters are regulated by the Clean Water Act, which sets standards for discharges through the National Pollution Discharge Elimination System (NPDES) Permit Program. (The NPDES program is implemented jointly by the EPA and the State DEQE. The state has applied for delegation authority.)

- State. Disposal of sanitary wastewater is regulated by local boards of health under the State Environmental Code (Title 5). The regulations set requirements for the siting and construction of on-site septic systems. Local boards of health may adopt reasonable regulations more stringent than Title 5.

  Discharge of sanitary wastewater to groundwater in excess of 15,000 gallons per day is controlled by DEQE under the Groundwater Discharge Regulations (314 CMR 5.00). All discharges must meet Surface Water Quality Standards (314 CMR 4.00) or Ground Water Quality Standards (314 CMR 6.00). These standards stipulate that discharges to Class I and II groundwater (or sources of potable water) must meet drinking water standards, while discharges to Class III groundwaters (or groundwater used for purposes other than potable water supply) may not contain pollutants in concentrations toxic to humans or causing significant adverse environmental effects.

- Local.

Beverly. The Board of Health adopted regulations governing the installation of individual sewerage disposal systems under M.G.L. Chapter 111, Section 31. These regulations extend Title 5 regulations relative to the allowed location and standards for sewage disposal works and septic tanks. Specifically, whereas Title 5 regulations determine the minimum area required for a disposal field based on the estimated sewage flow of the dwelling, Beverly's Board of Health regulations require that the disposal field for residential construction have a minimum area of 800 square feet.

Essex. Chapter VIII of the local General Bylaws modifies Title 5 of the Massachusetts Environmental Code as follows:

- 15.02(18) Multiple Use. Title 5 states that the use of subsurface sewage disposal systems by more than one lot is prohibited, Essex's Board of Health bylaws add that only one building per subsurface sewage system is permitted.

- 15.03(4e) Percolation Test. The minimum area requirements for leaching fields are variable under Title 5 and are determined by plotting the maximum flow per day and the percolation rate of the soils in the leaching area against a standard chart. The minimum area can be as low as 110 square feet. Essex's bylaws require a minimum of 800 square feet of leaching area.

- 15.03(7) Distances. Section 8-1 of the local bylaw increases the minimum distance between a septic system component and a water source from 50 feet under Title 5, to 100 feet.

Hamilton. The town has adopted supplements to Title 5 that require more stringent application procedures and plan specifications. Several addendums worth noting are:

- 15.02(13) Volume of Sanitary Sewage. Hamilton's sewage flow design is determined under slightly more stringent standards than Title 5. Title 5 sets discharge limits at 110 gallons per day (gpd) per bedroom for single and multiple dwellings and for motels, hotels and boarding houses. Hamilton's regulations mandate 200 gpd per bedroom with a minimum total flow of 1,000 gpd for single family residences and 250 gpd per bedroom with a 3,000 gpd minimum for multiple family residences. For non-residential systems, the regulation mandates the greater of 125% times Title 5 requirements or 200% of the average business day water consumption rate, and a minimum total sewage design flow of 1,000 gpd.

- 15.02(14) Type of System. Hamilton's regulations state that leaching fields and trenches are not permitted where leaching galleries, chambers and pits are technically feasible.

- 15.03(3) Deep Observation Wells. Hamilton requires observation wells to be sunk at least five feet below the leaching facility as opposed to four feet for Title 5. Hamilton's bylaw also states that where groundwater is not reached, it's assumed that groundwater is at the bottom of the deep observation hole.

- 15.03(4) Percolation Test. For acceptable septic system sites in the town of Hamilton, the slowest percolation rate permitted is 15 minutes per inch. Title 5 allows for a 30 minutes per inch percolation rate.

- 15.03(7) Distances. The local bylaws prohibit any part of a septic system within 100 feet of a waterway. Title 5 allows 50 feet clearance between septic tanks and water supplies and 100 feet clearance between leaching fields and water supplies.

- 15.06(1) Capacities. Title V requires septic tanks have a design flow not less than 1,000 gallons. Hamilton's regulations stipulate a minimum of 1,500 gallons.

- 15.06(2) Garbage Disposals. Garbage grinders increase the design flow capacity to at least 2,000 gallons under the local regulations as opposed to 1,500 as required by Title 5.

Manchester. The town has adopted several revisions to Title 5 of the State Environmental Code. These revisions include more specific data on site plans in order to facilitate the review process and reference to specific points without changing the language. However, the following sections contain some important changes:

- 15.02(13) Volume of Sanitary Sewage. The state sets the minimum daily sewage flow at 110 gallons per bedroom per day. Manchester sets this limit at 110 gallons per person per day with a minimum of two people per bedroom (or 220 gallons per bedroom per day) and further defines a bedroom as any room other than a living room, dining room, kitchen or bathroom.

- 15.02(18) Multiple Use. Title 5 prohibits more than one lot using a subsurface sewage disposal system. Manchester's bylaw stipulates one dwelling per individual sewage disposal system and each system must be entirely within the lot it serves.

- 15.02(23) Geohydrological Report on Clusters and Subdivisions. Manchester adds this section, beyond Title 5, to investigate the area 500 feet surrounding disposal systems designed to accommodate clusters or subdivisions.

- 15.03(4) Percolation Tests. Manchester's regulations require an area, equal to the disposal field, to be reserved for expansion of the system. They further mandate the system be designed for a minimum of four bedrooms or the actual number of bedrooms if more than four. Additional leaching area, as determined by the field, is required if garbage grinders are installed.

  Soils with percolation rates over 20 minutes per inch are considered impervious according to Manchester's bylaws, while Title 5 accepts soil perc rates under 30 minutes. Manchester also places a fast flow cap in percolation tests. Leaching areas which perc at rates of two minutes or less may require a 40% increase in capacity.

- 15.03(7) Distances. Manchester has adopted longer setbacks between the disposal facility and water courses. A minimum of 75 feet is required between the septage system and any streams, ponds, open and subsurface drains and wetlands. Title 5 requires a minimum of 25 feet between the facility and water courses.

- 15.06 Septic Systems. Title 5 requires a capacity of at least 1,000 gallons while Manchester's regulations requires a 1,500 gallon capacity minimum.

Wenham. There are no local board of health regulations controlling wastewater disposal.

Road Salt

- Federal/State. There are no state or federal regulations governing the application of road salt. The state policy is to treat all state roads under icy or snowy conditions with 100% salt at an application rate of 300 pounds per lane-mile. However, there are state and federal constraints on the amount of salt in potable drinking water supplies.

Drinking water standards as set out in the Safe Drinking Water Act (310 CMR 22.00) require that sodium levels not exceed 20 mg/l. If sodium levels exceed 15 mg/l, the water supply must be tested quarterly, and if sodium levels exceed 20 mg/l, the supplier must notify its customers of the high sodium level and potential hazards to health.

The Mass DPW has adopted a reduced salt policy for several critical water supply watersheds throughout the state, however none of these are within the study area. The DPW is also currently conducting a Generic EIR on its road deicing programs that will evaluate the impacts of road salt on water supplies.

o Local.

Beverly. There are no local regulations on road salt application in Beverly. Most main roads and hills are plowed and treated with straight salt and secondary roads are only plowed. The city does have a "low-salt" application policy on Cabot, Henderson, Trask, and Grover Streets within the Wenham Lake and Longham Reservoir watershed areas. These areas are treated with a 3:1 sand to salt mixture.

Essex. There are no local controls on road salt application in Essex. The town routinely uses a 19:1 sand to salt mixture on its roads, which is the minimum amount of salt needed to prevent the sand from freezing.

Hamilton. There are no local controls on road salt application in Hamilton. The town routinely applies a 10:1 sand to salt mixture on its roads.

Manchester. There are no local controls of road salt. Manchester treats town roads with a 4:1 sand to salt mixture. The town and the state have salt storage in Manchester. Mass DPW salt storage is near Gravelly Pond in the northeast corner of Manchester.

Wenham. The town of Wenham has a policy of restricting salt use throughout the town and the roads are posted for low salt at all borders to warn motorists. Salt is applied at a sand to salt ratio of 7:1 when necessary. The road leading to the town wells is treated with sand only.

Leachate

o Federal. There are no federal regulations concerning sanitary landfills.

o State. Landfills are operated under the DEQE regulations (310 CMR 19.00). These cover site selection, construction, cover material, litter and dust control, drainage of surface water, and completion and final cover of the landfill.

New state regulations have been drafted that afford much greater protection to groundwater. The new regulations require an impervious liner, groundwater monitoring systems, runoff guidance, and landfill capping. Although not formally adopted as state regulations, DEQE has been applying the standards of the new regulations to new or expanded landfills.

- Local.

  Beverly. There are no local controls regulating use of the landfill in the city.

  Essex. Section 7.2 of the General Bylaws assigns control of the town dump to the Department of Public Works. Regulations restrict who uses the dump and the size of the refuse. There are no regulations controlling types of materials accepted such as waste oil, paints, and other materials which can leach out and foul groundwater.

  Hamilton. Under Section XIII of the General Bylaws disposal of refuse and garbage is under the jurisdiction of the Selectmen and the Board of Health. The Board of Public Works in conjunction with the Board of Health is responsible for operation and maintenance of the landfill.

  Manchester. There are no local controls of landfill in the town.

  Wenham. The town has no regulations controlling landfills.

Hazardous Waste and Materials

- Federal. Hazardous waste generation, treatment, storage, transportation, and disposal are regulated by the Resource Conservation and Recovery Act (RCRA). The EPA has delegated authority to the Commonwealth of Massachusetts to carry out the program.

- State. The Massachusetts Hazardous Waste Management Act (Chapter 21C) and the DEQE hazardous waste regulations (310 CMR 30) establish a system of stringent control over hazardous wastes. All waste generators above a minimum threshold size are registered, and all wastes produced are accounted for in a "cradle-to-grave" manifest system. All wastes must be handled by licensed haulers and disposal facilities. There are standards for facilities which treat, store, and dispose of hazardous wastes. Waste generators are classified as large quantity generators if they generate over 1,000 kilograms per month of non-acutely hazardous wastes. Quantities of waste above the large quantity threshold must be removed from the site within 90 days. Small quantity generators are defined as those which generate between 20 and 1,000 kilograms per month of non-acutely hazardous wastes. Waste generators below that threshold are not regulated.

DEQE is currently drafting household hazardous waste regulations to assist communities in conducting household hazardous waste collections. DEM has provided several grants to communities for household hazardous waste collections, however the program is not currently funded.

- Local.

  Beverly. There are no local hazardous materials ordinances.

  Essex. There are no local hazardous materials bylaws.

  Hamilton. According to the Conservancy District regulations, "storage of chemical substances which may degrade water quality" are prohibited in wetland areas of the town. No other hazardous materials by-laws exist for the town. The town has a household hazardous waste collection program.

  Manchester. There are no local hazardous materials regulations. Manchester has run one household hazardous materials collection and is planning another collection.

  Wenham. There are no local controls of hazardous materials.

Pesticides

- Federal. The EPA tests pesticide products and approves their use, with label instructions for proper use.

- State. The Massachusetts Pesticide Board promulgated regulations for use of herbicides on rights-of-way in 1987 under 333 CMR 11.00. The regulations require that municipalities, utilities, and other organizations responsible for controlling vegetation on rights-of-way develop a Vegetation Management Plan and Yearly Operating Plan to be approved by the Department of Food and Agriculture. The regulations lay out specific controls on the use of herbicides regarding the height of vegetation, weather conditions during application, and touch-up applications. They also state that no handling, mixing, or loading of an herbicide concentrate is allowed on a right-of-way within 100 feet of a sensitive area, defined as an area:

  (a) within the primary recharge area of a public drinking water supply well;
  (b) within four hundred (400) feet of any surface water used as a public water supply;

(c) within one hundred (100) feet of any appropriately marked private drinking water supply well;
(d) within one hundred (100) feet of any standing or flowing water;
(e) within one hundred (100) feet of any wetland;
(f) within one hundred (100) feet of any agricultural or habitated area.

Under the regulations, municipalities may propose that the Department impose specific additional restrictions or conditions on the use of herbicides within or adjacent to sensitive areas as it determines necessary to protect human health or the environment. These allow for greater protection of public surface water supplies, private drinking water supplies, surface waters, wetlands, and habitated and agricultural areas.

- Local.

  Beverly. There are no local controls on pesticide use. Beverly is a member of the Essex County Mosquito Control Program.

  Essex. There are no local pesticide controls, however, Essex is not a member of the Essex County Mosquito Control Program.

  Hamilton. There are no local controls of pesticides in Hamilton. Hamilton is a member of the Essex County Mosquito Control Program.

  Manchester. There are no local pesticide regulations. Manchester is a member of the Essex County Mosquito Control Program but they do not participate in the spray application process.

  Wenham. There are no local controls of pesticides in the town, however, Wenham is not a member of the Essex County Mosquito Control Program.

Mining (Sand & Gravel Excavation)

- Federal/State. There are no state or federal regulations governing sand and gravel excavation.

- Local.

  Beverly. Under Section 29-5 L of the City of Beverly Zoning Ordinance, the removal of sod, loam, gravel, or other mineral matter for commercial purposes requires approval of the Board of Appeals. Certain activities are exempted from this requirement, such as the construction and operation of wells for water supply or excavation for trenches for drainage or sanitary purposes, except in the case of new subdivisions, in which case permission must be obtained from the

Planning Board. There are no standards regarding the required depth of excavation of material.

Essex. Under Section 4.8 of the General Bylaws, permits must be obtained from the Board of Selectmen and the Planning Board for excavation and removal of loam etc. The bylaw does not place restrictions on the depth of excavation to assure a buffer zone to the water table.

Hamilton. There are no local controls of mining, or of sand and gravel operations in the town. However, Hamilton's General Bylaws grant permitting authority for removal of soil, loam, sand or gravel to the Board of Selectmen. there are no restrictions on excavation depth.

Manchester. Article XII of the General Bylaws regulates earth removal. Permits for soil, loam, sand, gravel and rock removal must be obtained from the Board of Selectmen. There are no restrictions on excavation depths.

Wenham. Section VII of the town's Zoning Bylaws regulates removal of soil, loam, sod, sand, gravel and quarried stone. The Planning Board issues permits for removal of these materials. The bylaw addresses concerns for grade, noise, dust and other public nuisance issues, but sets no restrictions on depth of excavation except that such activity cannot constitute a hazard to the public health and welfare of the town, and will not prohibit re-use of the land.

ZONING

The preceding section summarized the laws and regulations which affect existing land uses in the city and towns. Zoning determines the type and intensity of development which may occur in the future within defined districts of the community. As such, it is one of the most important tools at the community's disposal to insure the long-term protection of its water supplies. By defining critical water resource areas and restricting future land uses within those areas, each community can insure that incompatible or hazardous land uses do not threaten water quality in the future. Sound management of the land use in the aquifer and watershed areas will not only protect the public health, it will also help prevent a contamination incident which could cost millions of dollars in treatment and clean-up costs, and severly restrict availability of adequate water supplies.

The zoning bylaws for each of the members of the intercommunity water quality study are summarized below, with a focus on those aspects which could affect water resources.

BEVERLY ZONING DISTRICTS

Eight zoning districts fall within the water study area of Beverly. Five of these districts, comprising 84% of the study area, are zoned for one-family residences, two districts--0.3% of the area--are zoned for commercial use, and one district, comprising 11.1% of the area, is zoned for restricted industrial, research, and office use (see Table 5-1). Almost 52 acres, within the 1,752 acres that make up the water study area, are undeveloped and owned by the City of Beverly, the Salem & Beverly Water Supply Board, or the Beverly Conservation Commission. Table 5-2 summarizes allowed and special permit uses in the zones and notes the potential water supply impacts for each. Relative percentages of zoning districts for Beverly are shown in Figure 5-2.

Table 5-1
Beverly Zoning in the Water Study Area

Zone	Area (acres)	% of Area	Minimum Lot Size
R-10, 15, 22	980	55.9%	under 22,000
R-45	402	23.0%	45,000
R-90	89	5.1%	90,000
CG, CN	6	0.3%	under 15,000
IR	195	11.1%	90,000
Water	80	4.6%	--
Total	1,752	100.0%	

Figure 5-2

Beverly Zoning Comparison

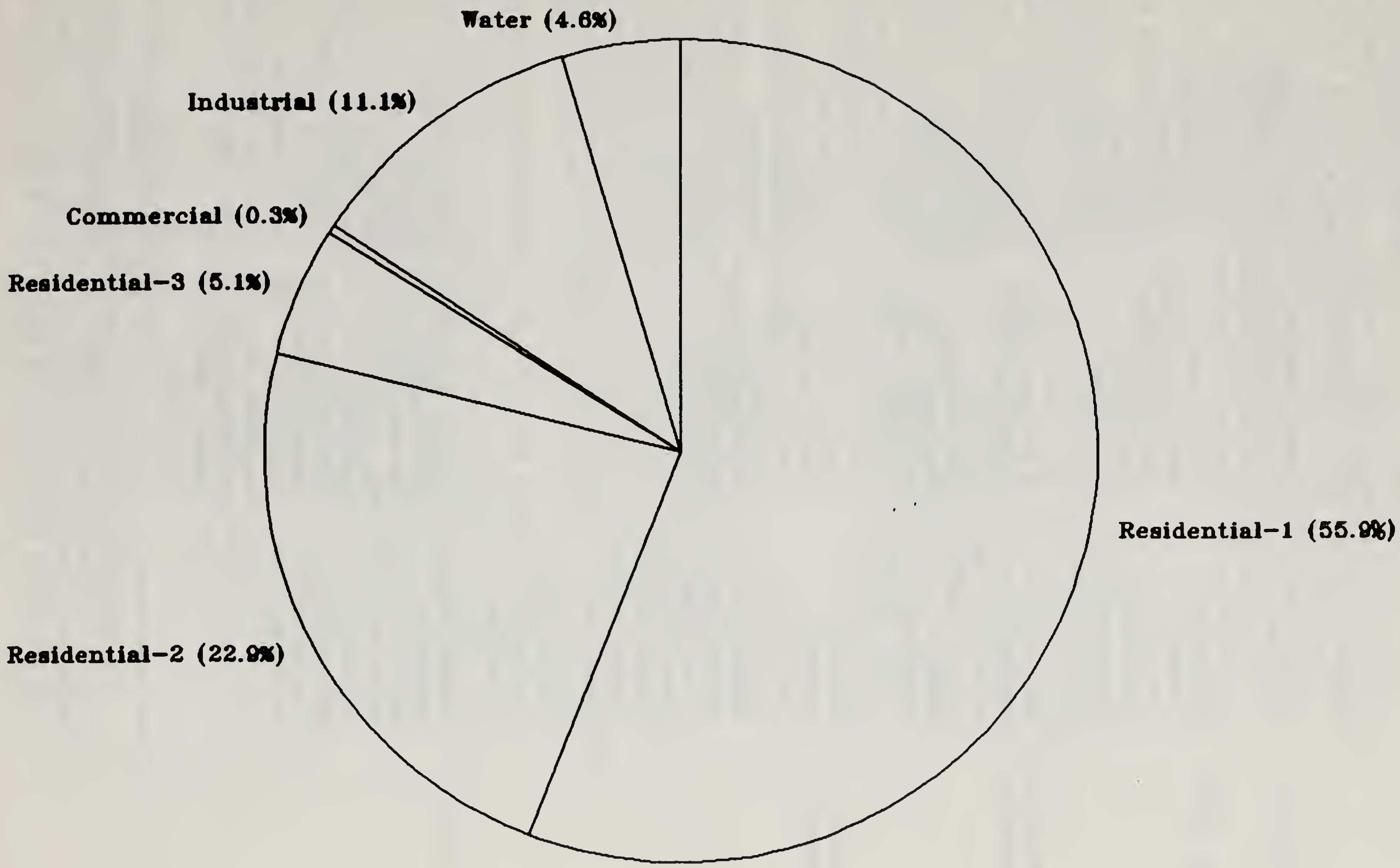


Table 5-2
Beverly Zoning Analysis - Water Supply Impacts

Zoning District	Uses Allowed By Right	Uses Allowed By Special Permit	Potential Water Supply Impacts
Residence	Residence, Museums, Landfills, Agriculture, Government, Church, School	Elderly housing, Marinas, Stables, Public utilities, Recreational facilities	Septic systems, Underground fuel, Pesticides, Fertilizers, Urban runoff
Neighborhood Commercial	Residence, Landfills, Retail, Office space, Funeral homes, Agricultural	Elderly housing, Clubs, Marinas, Stables, Restaurants, Transportation terminals, Public utilities	Septic systems, Hazardous materials, Underground fuel, Urban runoff
General Commercial	Residence, Museums, Landfills, Hotels/motels, Retail, Recreational clubs, Office, Funeral homes, Restaurants, Commercial, Recreation, Agriculture, Transportation Terminals, Automotive	Elderly housing, Clubs, marinas, Stables, Public utilities, Gas stations, Parking lots/garages	Septic systems, Hazardous materials, Underground fuel, Urban runoff
Industrial	Manufacturing, Museums, Landfills, Public utilities, Office, Agriculture, Transportation terminals	Elderly housing, Hotels/motels, Marinas, Stables, Restaurants, Commercial, Recreation, Animal hospitals/kennels, Automotive, Craftsmen shops, Warehouses/open storage, Parking lots/garages	Septic systems, Hazardous materials, Underground fuel, Urban runoff

Beverly Residential District.

The residential districts comprise 84% of the water study area. They include R-10 (10,000 sf), R-15 (15,000), R-22 (22,000 sf), R-45 (45,000 sf) and R-90 (90,000 sf). Each of these districts was established to provide for single-family residences and, under special conditions, related recreational, agricultural, and educational facilities. Subsidized elderly housing, marinas, stables, public utilities, and certain recreational facilities are allowed by special permit.

Beverly Neighborhood Commercial District.

Less than one acre of land is zoned as CN in the water study area. This district allows for a density of the least restrictive adjacent residential district. In the water study area, only one small parcel is zoned CN and sits within an area zoned as R-15. Therefore, the district, in this instance, requires minimum lot sizes of 15,000 sf. The district was established to allow for limited commercial development to serve adjacent residential neighborhoods. Neighborhood Commercial land uses include residences, agriculture, landfills, office and retail space, and funeral homes. Uses such as subsidized elderly housing, marinas, stables, recreational clubs, restaurants, transportation terminals, and public utilities require a special permit.

Beverly General Commercial District.

Approximately five acres within the water study area are zoned CG. This district was established to provide suburban and automotive related commercial development outside of residential areas. Residences and related uses are allowed in this district, as well as hotels/motels, recreational clubs, transportation terminals, and automotive-related activities. However, gasoline stations and parking lots/garages are allowed only under special permit; and sites for heavy repair work on vehicles are prohibited.

Beverly Restricted Industrial, Research, and Office District.

The IR District makes up close to 11% of the water study area. This district was established to provide for office complexes, light industrial parks, and necessary support facilities, including ancillary storage, service, and retail uses. Within this district, such activities as manufacturing, assembly, processing, packaging, and research and testing operations; printing and publishing establishments; transportation terminals; and public utilities are allowed. Other activities such as hotels/motels; restaurants; animal hospitals and kennels; auto body or paint shops; contractors or craftsman shops; warehouses and open storage; public utilities; and parking lots/garages require a special permit. The portion of this zoning district within the water study area is unsewered.

Beverly Special Density Provisions

Planned Residential Development. PRDs were established to provide for flexibility in residential development and a mixture of housing types, as well as to conserve open space and natural amenities. In the water study area, the Board of Appeals may grant a PRD permit in an R-22 or R-45 district to allow for the construction of one-family dwellings, two-family dwellings, multi-family dwellings, public or private schools, public recreation and open space, fire stations and other public facilties, and membership clubs for the exclusive use of residents of the PRD. At least thirty (30) percent of the gross area of the PRD must be preserved as open space.

"Cluster" Development. This allows for subdivision development in which the requirements for individual building lots would be reduced without an increase in the allowable gross density of the subdivision based on normal lot requirements. Approval must be granted by the Planning Board. Within the water study area, zones R-10, R-15, R-22, and R-45 may receive approval for cluster development. Requirements under this provision include that all subdivided lots will be served by public water and sewer systems; and that any remaining area not dedicated for streets and other public right-of-ways and not plotted into building lots must remain as open space.

Accessory Apartments. The Zoning Board of Appeals may grant approval for the alteration of an existing single-family residence to include up to one accessory apartment per dwelling in any residential zone.

Congregate Housing. A Special Permit may be granted by the Planning Board in any residential district for congregate housing for the elderly and/or permanently disabled.

Beverly Resource Protection Overlay Districts

Floodplain Overlay District. An FOD was established to protect the health and safety of residents subject to flooding and minimize future damage resultant from flooding. Any permitted uses in this district must comply with the Commonwealth State Building Code, section 744. The city also prohibits fill, new construction, substantial improvements to existing structures, and other developments in the floodway.

Watershed Protection Overlay District. This district was established to protect against the contamination of existing and future water supplies as well as preserve water supplies for future use. This district is located in the northwestern portion of Beverly, including Wenham Lake, but does not overlay the entire water study area delineated for this project. Allowed uses in this area include conservation of natural resources; outdoor recreation not involving motorized land or water vehicles; pathways; expansion of existing residential structures; new single-family residences; land harvesting; and the operation and maintenance of public water supply facilities. Uses that require a Special Permit include commercial and industrial uses and two-family and multi-family developments permitted in the underlying district. Uses prohibited in this district include: storage of chemical or petroleum products; disposal of hazardous materials, solid wastes, leachable wastes, and snow containing deicing chemicals; storage of road salt or other deicing materials; industrial uses that discharge process wastewater on site; outdoor storage of fertilizers, herbicides, pesticides, and uncovered manure; animal feedlots; drycleaning establishments; boat and motor vehicle-related services; junk and salvage yards; septic sewerage systems; and natural resource mining or commercial sand and gravel operations.

Beverly Subdivision Regulations

All Definitive Plans for subdivisions must be approved by the Planning Board after the Board has reviewed data and comments from the Board of Health, Public Works Department, Police Department, Fire Department, and City Engineer. The Board of Health is required to submit a statement of approval or disapproval to the Planning Board within 45 days of the filing.

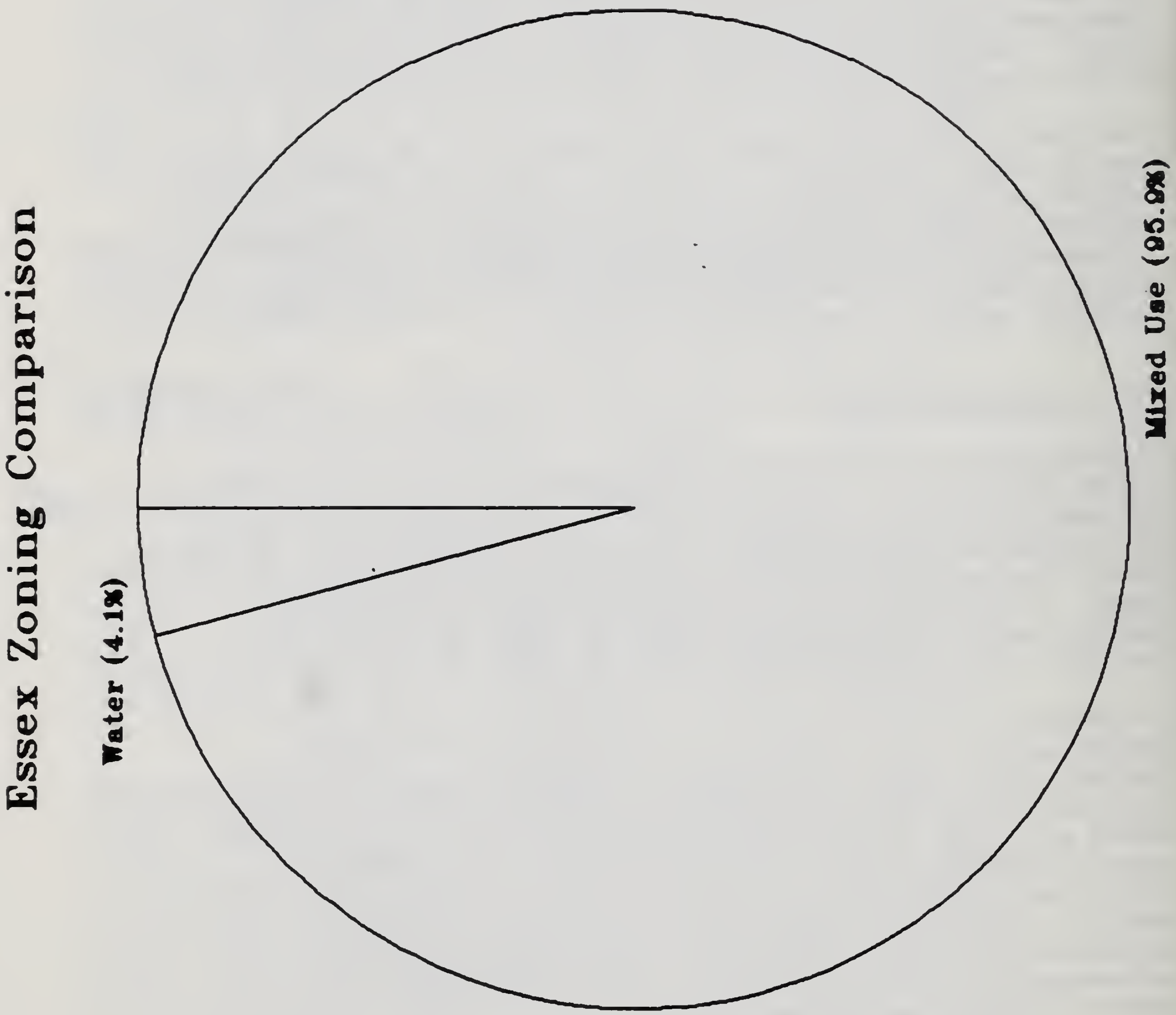
The Planning Board may require, at the expense of the applicant, soil surveys and/or test borings to establish the suitability of the land for the proposed sewerage disposal system, storm drainage system, and proposed street construction. Specific standards for lot drainage and sewerage are also included in the subdivision regulations. However, the subdivision regulations do not specifically address potential impacts on groundwater resources.

ESSEX ZONING DISTRICTS

Although Essex has zoning requirements as set forth in their General Bylaws, they differ from the other towns in the study area by not delineating specific zoning districts tied into a base map. As long as a proposed development meets the specific requirements of the General Zoning Bylaw, it can be placed anywhere in the town of Essex. Therefore, development which may pose a threat to water quality, such as commercial or industrial uses, may be located anywhere within the water resources study area.

According to the General Bylaws, six land uses are permitted throughout the town. These uses are residential (1 and 2 family), business, motel/hotel, and industrial (class A and B) with lot requirements as listed in Table 5-3. Some uses allowed by special permit are larger residences (3 or more families), airports and schools (see Table 5-4). The wetlands district designated in Essex will allow agriculture and forestry, but prohibits dumps and dredging. Within the water resource study area, 2,580 acres are mixed-use and 110 acres are water. Figure 5-3 displays the percentage of mixed use zoning to surface water areas in Essex for comparison to the other communities.

Figure 5-3



Essex Zoning Comparison

Table 5-3
Essex Zoning of the Water Study Area

Permitted Uses	Maximum % impervious cover	Minimum Lot Size
Residential (1 family)	25	40,000
Residential (2 family)	25	40,000
Business	25	40,000
Motel/Hotel	--	90,000
Industry (Class A)	33	90,000
Industry (Class B)	25	40,000
Special Permits		
Residential (3 dwellings)	50	60,000
Residential (4 or more dwellings)	50	90,000

Table 5-4
Essex Zoning Analysis - Water Supply Impacts

Zoning District	Uses Allowed By Right	Uses allowed By Special Permit	Potential Water Supply Impacts
Residential, Industrial, Motel/hotel, Business	Residences, Industry, Motel/hotel, Businesses	Airports, Recreation facilities, Schools, Public utilities, Radio and television installations, Trucking terminals, Hospitals, Nursing homes	Septic systems, Underground fuel, Pesticides, Fertilizers, Urban runoff, Salt, Household hazardous waste
Wetlands	Agriculture, Aquaculture, Forestry, Conservation land, Recreation		Pesticides, Fertilizers

Essex Wetland Districts

Essex's wetland districts overlay all other zoning areas and are tied into a wetlands map dated April, 1974 on file with the Town Clerk. Zoning in these areas is provided under MGL Chapter 131, Section 40 and Title 5 of the Commonwealth of Massachusetts Sanitary Code.

Essex Flood Plain District

The flood plain district in Essex was established in July, 1986 as an overlay district. Any activities in Zone A as set forth on the Flood Insurance Rate Maps for the town must be reviewed by the Building Inspector to assure compliance with elevation and flood-proofing requirements under the State Building Code. No developments may be located in Zone V (or seaward of the mean high tide mark).

Essex Subdivision Regulations

Under Essex's subdivision regulations, a Definitive Plan must be reviewed and approved by the Planning Board. Plans must also be submitted to the Board of Selectmen, Board of Health, Department of Public Works, Conservation Commission, Chief of Police and Fire Chief who will submit recommendations to the Planning Board. Subdivision regulations require adequate easements for waterways and provides for open space at a minimum of one acre for each twenty single family dwelling units. In case of non-residential subdivisions, open space shall be equal to three times the floor area of all other dwellings and 10% of the total land area. Stipulations are made in the regulations for preservation of natural features and drainage and sediment control. Resubdivisions are permitted. However, the subdivision regulations do not specifically address potential impacts on groundwater resources.

HAMILTON ZONING DISTRICTS

Hamilton has four zoning districts and two overlay districts. All of the aquifer area in Hamilton is zoned residential, comprising a total of 3,322 acres (see Table 5-5). An additional 157 acres in the water study area consists of water. Figure 5-4 demonstrates the relative percentages of the various zones in the water study area of Hamilton. Hamilton also has a Conservency District and a Groundwater Protection District (see Table 5-6). The Groundwater District places restrictions on lot sizes.

Table 5-5
Hamilton Zoning in Aquifer Area

Zone	Area (acres)	% of Area	Minimum lot size
R1a	1,434	41.2%	under 40,000
R1b	583	16.8%	40,000 and above
RA	1,305	37.5%	80,000 and over
Water	157	4.5%	
Total	3,479	100.0%	

Figure 5-4

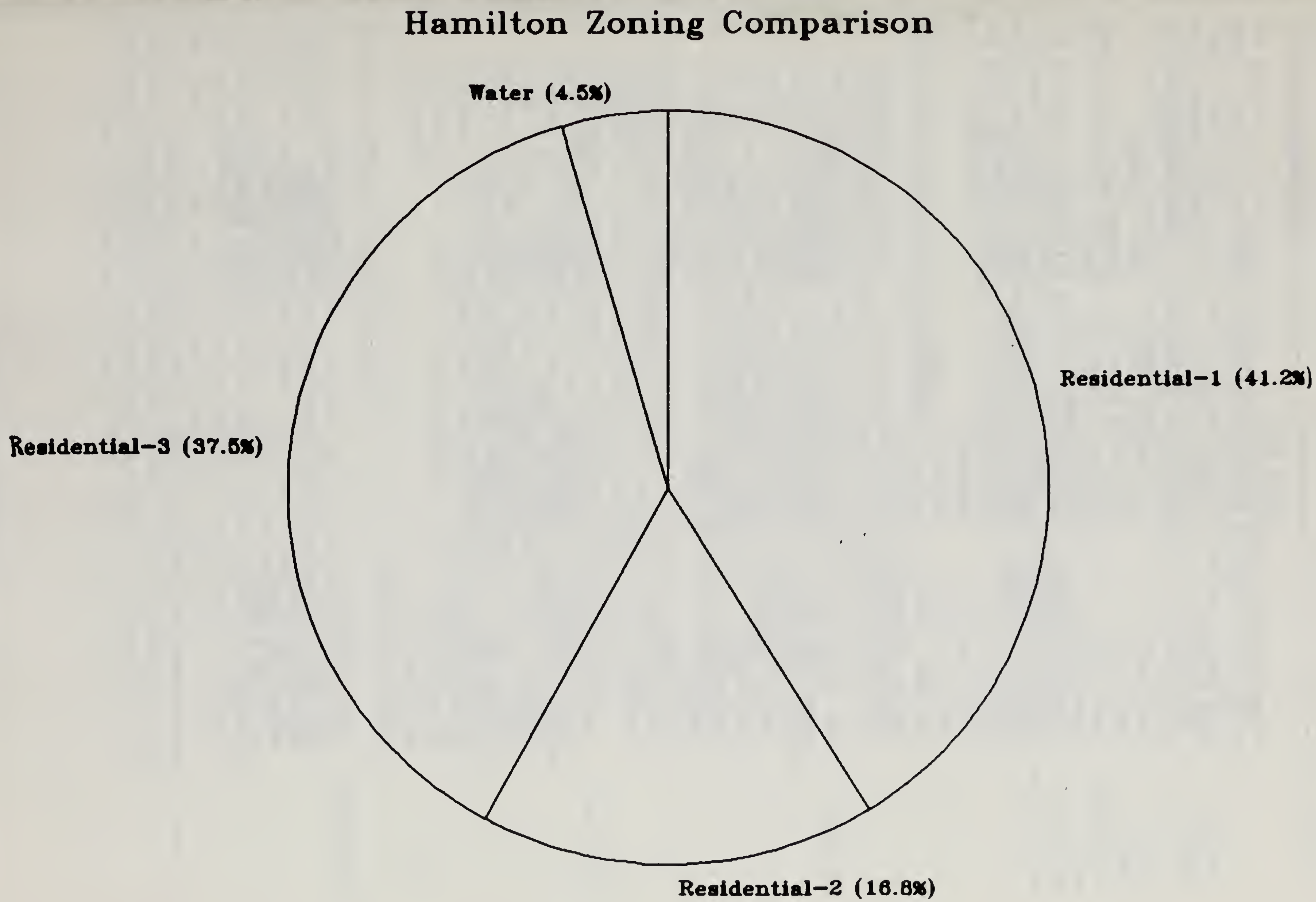

Hamilton Zoning Comparison
Water (4.5%)
Residential-1 (41.2%)
Residential-3 (37.5%)
Residential-2 (16.8%)

Table 5-6
Hamilton Zoning Analysis--Water Supply Impacts

Zoning District	Uses Allowed By Right	Uses Allowed By Special Permit	Potential Water Supply Impacts
Single family residences, and Residence agricultural	One family detached dwellings, Agriculture, Forestry, Rooming houses, Churches, Schools, Museums, Parks, Playgrounds, Private schools, Colleges, Golf, Tennis, Swimming, Home occupation	Multi-family units in an R-1a District, Hospital, Cemetery, Nursing home, Private club, Commercial farming, Farm stand, Garaging five vehicles, Temporary amusements, Wind energy, Scientific research	Septic systems, Underground fuel, Pesticides, Fertilizers, Urban runoff, Salt, Household hazardous waste
Business	All uses permitted in above zone, plus Retail stores, Services, Business, Nonprofit civic buildings, Parking lots, Garages	Gas stations, Service repairs, Rail or bus stations, Funeral homes, Manufacture of goods sold on premise	Septic systems, Underground fuel, Pesticides, Fertilizers, Urban runoff, Salt, Hazardous waste
Conservancy	Conservation of water, Plants, Ponds, Wildlife, Passive recreation activities, Agriculture, Forestry, Religious and educational uses	Buildings, Boathouses, Landings, Farm stands, Dams, Drainage, Scientific research	Septic systems, Underground fuel, Pesticides, Fertilizers, Salt
Groundwater	Uses permitted for the underlying zone except lot size is to be 80,000 sq. ft.		Septic systems, Pesticides, Fertilizers, Urban runoff, Salt, Household hazardous waste

Hamilton Residential District

The residential districts, R1a, R1b and Residence-agriculture cover 100% of the aquifer area. The uses permitted by these districts are single family dwellings, rooming houses of four persons, churches, schools, parks, playgrounds, private colleges, tennis, skiing, golf and home occupations provided there is no offensive noises, storage of materials or more than two employees.

Hamilton Business District

The Business District in Hamilton allows for all uses permitted in Residence 1a and 1b as well as retail stores, service establishments, offices and banks, government buildings, parking lots and garages. The small business district located in Hamilton is found outside the Water Supply area.

Hamilton Overlay Protection Districts

Conservancy District. The Conservancy District or wetlands district overlays parts of the three residential districts and the business district and is designed to conserve natural conditions, wildlife, and open spaces for the education, recreation and general welfare of the public. Permitted uses are passive recreation, agriculture, forestry, religious and educational uses. Uses prohibited in the district are land filling, buildings, pavement, storage of materials, dams, drainage and water course changes, and alteration of terrain.

Hamilton Flexible Plan Subdivisions. The purpose of the groundwater protection district is to protect, preserve and maintain the existing and potential groundwater supply, groundwater recharge areas, and municipal wellfields within Hamilton. In this district new underground installations of heating oil storage tanks and farm or residential tanks less than 1,100 gallons storing motor oil/fuel are prohibited. Lots must be equal to or greater than 80,000 square feet in area. This district covers the town's two aquifers defined by hydrogeologic studies, but it does not cover portions of the water study area related to the Gravelly Pond, Round Pond, and Essex River watersheds.

Hamilton Flexible Plan Subdivisions

Flexible plan subdivision is intended to provide the option of an alternative pattern of land development which preserves significant natural or agricultural open space and scenic views, but does not increase overall dwelling numbers. This is intended to create cluster development that is environmentally and visually preferable. The character shall remain single-family and semi-rural. The total plan has a minimum parcel size of ten acres. Individual lot size must be 10,000 square feet, communal septic systems are permissible and water supply may be municipal or private. Forty percent of the parcel must be dedicated as permanent open space. No more than 25% of this open area can be considered under Conservancy District, or

Wetlands under M.G.L. Chapter 31, Sec. 40. No lot in the plan may be further subdivided. These plans must come under review by the Hamilton Board of Health.

Hamilton Subdivision

Before making any division of land in Hamilton, the subdivider is required by law to secure, from the Hamilton Planning Board, approval or endorsement of the plan for the proposed division. This control law was enacted to protect the people of the town, to insure safety, sanitary conditions and compliance with zoning, and for securing adequate provision for water, sewage and drainage. However, the subdivision regulations do not specifically address potential impacts on groundwater resources.

MANCHESTER ZONING DISTRICTS

The 2,809 acre water study area falls within all six of the Town of Manchester's zoning districts (see Table 5-7). Four of these districts are residential, three are single-family zones, and one is a two-family zone. The other two districts are the General District that allows municipal and retail uses, and the Limited Commercial District that allows municipal, office, research, and light manufacturing uses. Table 5-8 summarizes allowed and special permit uses in the zones and notes the potential water supply impacts for each. Figure 5-5 demonstrates the relative percentages of the various zones in the water study area of Manchester.

Table 5-7
Manchester Zoning of the Water Study Area

Zone	Area (acres)	% of Area	Minimum lot size
Residence A, B & D	1,046	37.2%	6,000 - 22,500 sf
Residence C	838	29.8%	45,000 sf
General District	41	1.5%	6,000 sf
Limited Commercial	884	31.5%	5 acres
Total	2,809	100.0%	

Figure 5-5

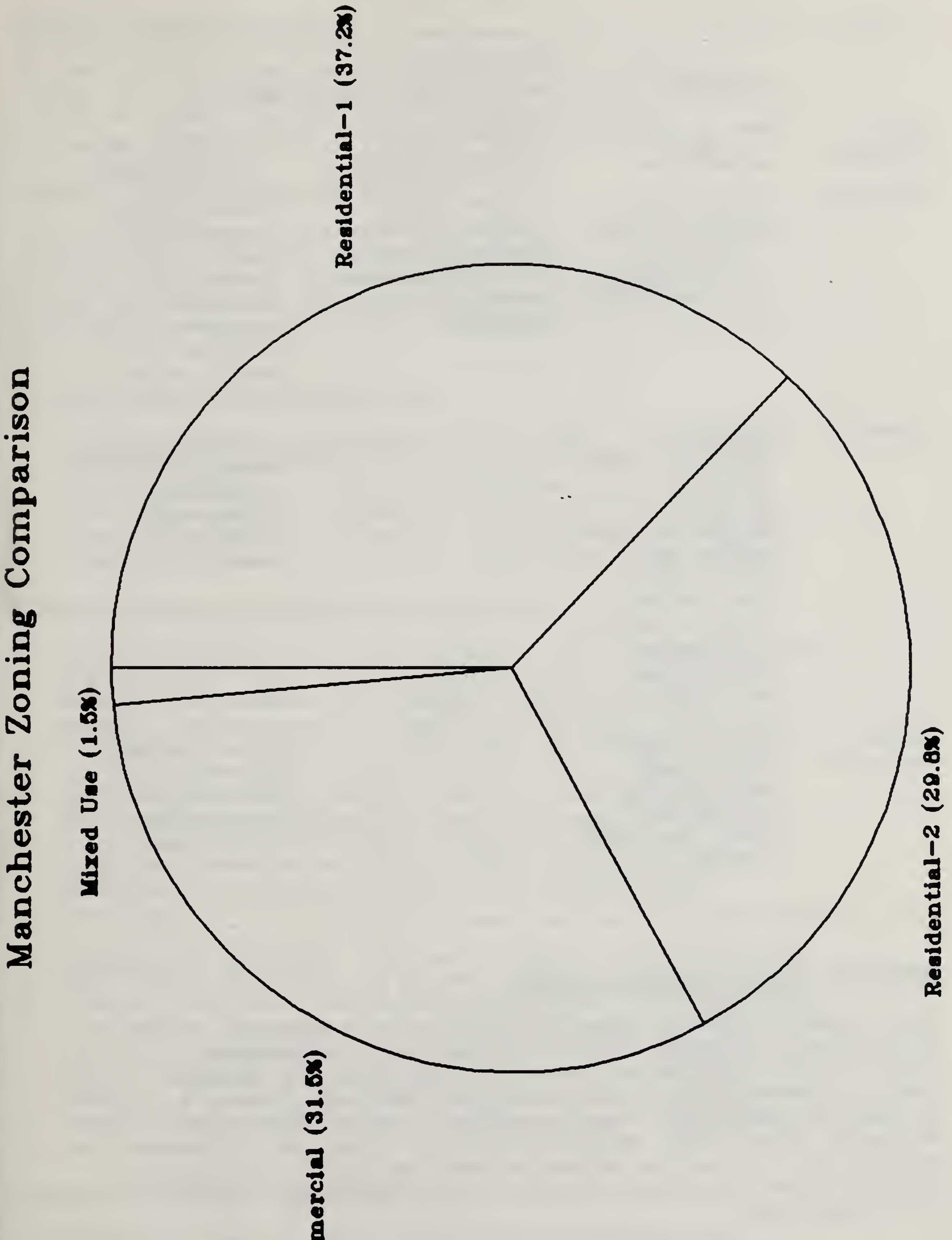

Manchester Zoning Comparison
Residential-1 (37.2%)
Residential-2 (29.8%)
Commercial (31.5%)
Mixed Use (1.5%)

Table 5-8
Manchester Zoning Analysis--Water Supply Impacts

Zoning District	Uses Allowed By Right	Uses allowed By Special Permit	Potential Water Supply Impacts
Residence	Residence, Church, Schools, Parks and playgrounds, Municipal offices	Private clubs, Cemetery, Public utility, Swimming pool, Tennis court, Garaging of four vehicles	Septic systems, Underground fuel, Pesticides, Fertilizers, Household hazardous waste, Urban runoff
General	Residence, Municipal, Public utilities, Retail, Restaurants, Boat storage or construction, Fish landing or storage, Parking, Greenhouses, Printing and publishing		Septic Systems, Hazardous materials, Underground fuel, Urban runoff
Limited commercial	Office, Research labs, Light manufacturing, Recreational clubs, Municipal parking		Septic systems, Hazardous materials, Underground fuel, Urban runoff

Manchester Single Residence Districts

The residential districts comprise 67% of the water study area. They include Single Residence District A (minimum lot size 22,500 sf); Single Residence District B (minimum lot size 15,000 sf); Residence District C (minimum lot size 45,000 sf); and Residence District D (minimum lot size 6,000). Residence Districts A, B, C only allow single-family dwellings. Residence District D allows similar uses of Districts A, B, C, but also allows two dwelling units. All the above districts allow agricultural, religious, educational, and park-related uses.

Manchester General District

The General District requires a minimum lot area of 6,000 sf. Allowed uses include municipal, retail and office, yacht storage and related activities, fish and shellfish landings, parking, horticultural, and printing and publishing establishments.

Manchester Limited Commercial District

This district allows uses such as office space, scientific research and development, light non-nuisance manufacturing, recreation, municipal, and parking. Minimum lot size is five acres with a maximum lot coverage of 20%, maximum parking use of 25% of the lot area, and maintenance of natural or landscaped area of a minimum of 25% of the lot area.

Manchester Special Density Provisions

Planned Residential Development District (PRD). The Manchester Planning Board may grant a special permit for a PRD in Single Residence District C. The required minimum tract size is 50 acres with a maximum development (including all structures and paved areas) of 30% of the parcel. The remaining 70% must be preserved for common open space for land preservation purposes.

Manchester Resource Protection Overlay Districts

Wetlands District. This district overlays other zoning districts and consists of those areas designated as ponds, deep fresh marshes, fresh marshes, shrub swamps, wooded swamps, and salt marshes. Any use otherwise permitted in the underlying district is permitted as a matter of right within the Wetlands District, except for the following uses: storage of salt, chemicals, petroleum products, or similar substances; dumping of soil or other materials or excavation, dredging or removal of natural resource deposits; construction of new buildings or enlargement/moving of existing buildings; and discharge of substances that may cause the pollution of wetlands and waterways.

Flood Control District. This overlay district serves to protect public health and safety and property against the damages of flooding conditions. Uses otherwise permitted in the underlying district are allowed as a matter of right, except the following activities which require a special permit from the Board of Appeals: dumping of soil or other materials or excavation, dredging, or removal of natural resource deposits; and the construction of new buildings or enlargement/moving of existing buildings.

Manchester Subdivision Regulations

All Definitive Plans for subdivisions must be approved by the Planning Board after the Board has reviewed all data and received comments from the Board of Health, Public Works Department, Police Department, Fire Department, and City Engineer. The Board of Health is required to submit a statement of approval or disapproval to the Planning Board within 45 days of the filing. However, the subdivision regulations do not specifically address potential impacts on groundwater resources.

WENHAM ZONING DISTRICTS

Wenham has two zoning districts and a floodplain overlay district. The residential district covers nearly all of the town while the business district is confined to a small section of Route 1A along the Hamilton border and a small parking parcel along Route 1A near Friend Court. Wenham's aquifers are zoned almost entirely residential (see Table 5-9). About 3,370 acres, or 96 percent of the water study area, is zoned for residential uses, one four acre parcel is zoned for business, and the remaining area is open water. Figure 5-6 demonstrates the relative percentages of these zones in the water study area of Wenham. Table 5-10 summarizes allowed and special permit uses in the zones and notes the potential water supply impacts for each.

Table 5-9
Wenham Zoning in the Water Study Area

District	Area in Aquifer	Percent of Aquifer Area	Minimum Lot Size
Residential	3,370	95.9%	40,000
Business	4	0.1%	40,000
Water	141	4.0%	--
Total	3,515	100.0%	

Figure 5-6

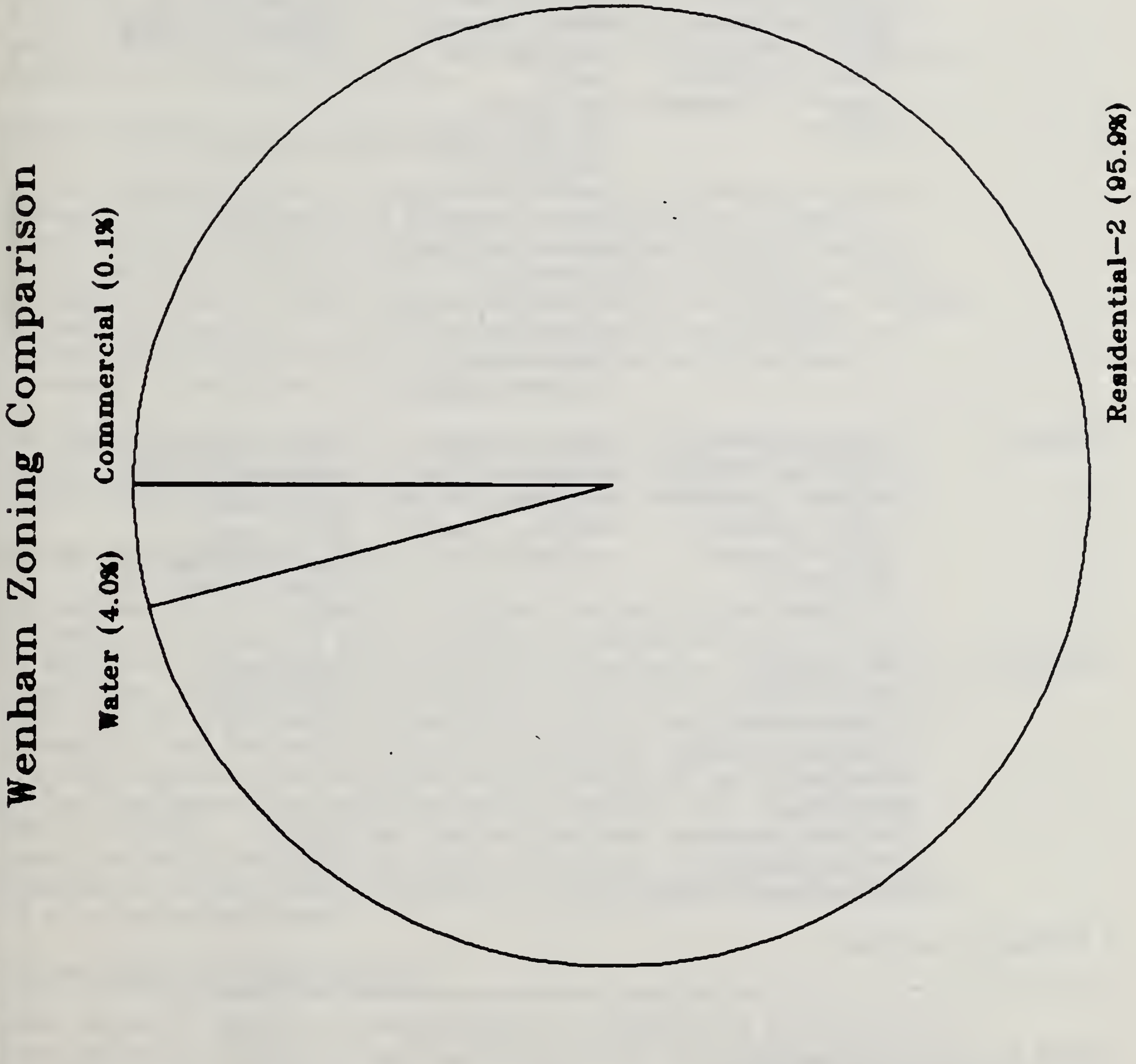

Wenham Zoning Comparison

Table 5-10
Wenham Zoning Analysis - Water Supply Impacts

Zoning District	Permitted Uses	Special Permit Uses	Potential Impacts
Residential	Residence, Education, Religious, Agriculture, Horticulture, Floriculture, Roadside stands, Mobil homes*, Travel trailers*, Campers*, Swimming pools*	Cemeteries, Greenhouses, Nurseries, Hospitals, Sanitoriums, Convalescent homes, Elderly housing, Two family apartments, Offices, Home manufacture, Social, Civic and church function booths, Day care, Municipal buildings, Parks, Playgrounds, Summer camps, Scientific uses	Septic systems, Underground fuel, Pesticides, Salt, Fertilizers, Urban runoff, Household hazardous wastes
Business	All residential uses plus Retail, Wholesale, Service establishments, Offices, Banks, Restaurants, Utilities	Municipal use, Newspapers, Job printing, Filling stations, Repair garages	Septic systems, Underground fuel, Pesticides, Fertilizers, Hazardous wastes, Urban runoff, Salt
Floodplain	Agriculture, Horticulture, Floriculture, Roadside stands, Woodland, Grassland, Wetland, Outdoor recreational, Buildings*, Sheds*		Pesticides, Fertilizers

* Accessory Uses Only.

Wenham Residential District

The residential district, comprising approximately 96% of the water study area, permits family dwellings, educational religious, agricultural, horticultural, floricultural uses and road side stands. Uses allowed by special permit are cemeteries, greenhouses and nurseries, hospitals, sanitoriums, convalescent homes and elderly housing, two family housing, professional offices, home manufacturing, social civic and church function booths, day care, municipal buildings, parks, playgrounds, summer camps and scientific uses. The minimum area for lots in the residential district are 40,000 square feet.

Wenham Business District

Business District uses permitted in Wenham include those uses permitted under residential zoning plus retail/wholesale stores, service establishments, offices or banks, restaurants, and telephone, telegraph and electrical utilities. By special permit, municipal uses, newspaper and job printing, and filling stations and repair garages are also allowed. The minimum area requirements for business zoned lots is 40,000 square feet.

Wenham Floodplain and Wetlands Districts

Wenham Floodplain District includes all areas of the town below an elevation of forty feet, not occupied by buildings as of March, 1970. These and additional areas are delineated on the Floodplain Zoning Map on file with the Planning Board. No buildings shall be erected, altered or used in this district unless for purposes related to woodland, grassland, wetlands, agricultural, horticultural or outdoor recreational use of land or water. No sustained human occupancy is permitted in this district.

The Wetlands District is delineated on a map entitled "Wetlands Study, Wenham, Massachusetts," November, 1975. Activities in this district are controlled by the State Wetlands Protection Act.

Wenham Water Resources Protection Bylaw

The purpose of the by-law is to protect the water resources, wetlands, and adjoining areas in Wenham by prior review and control of activities deemed by the Conservation Commission likely to have a significant or cumulatively detrimental effect upon public or private water supply, groundwater, fisheries, wildlife, wildlife habitat, recreation, and aesthetics, and the prevention and control of flooding, erosion, sedimentation, storm damage, or pollution. The by-law complements the state Wetlands Protection Act, but differs from the Act by: placing isolated and seasonal wetlands under the town's jurisdiction; allowing other town boards to comment on proposed activities; and, establishing a schedule of fees for permits to alter protected areas.

Wenham Subdivision Regulations

Under Wenham's Subdivision Regulations, all Definitive Plans must be approved by the Planning Board, which relies on the Board of Health, the Conservation Commission, the Superintendent of Streets, the Police Department, the Fire Engineers, the Water Board and other appropriate town agencies for comment. Subdivisions are limited to one unit per 40,000 square feet of land exclusive of flood plain or wetlands or as set forth under Open Space Residential Developments (OSRD). Open Space Residential Developments are permitted if the tract of land to be developed contains not less than fifteen (15) acres exclusive of flood plain and wetlands. Under the standards set for OSRD subdivisions, 35% of the buildable land area is to remain as open space with limited easement for public access. The permanent open space areas must be conveyed to: (a) the Town of Wenham, (b) a non-profit conservation or preservation trust or association or, (c) a corporation or trust comprising a home association whose members include owners of all lots contained in the tract and under restrictions which provide that the open space shall be kept in an open or natural state. However, the subdivision regulations do not specifically address potential impacts on groundwater resources.

NORTH SHORE SUMMARY

A comparison of zoning districts for the North Shore study area is shown in Figure 5-7.

Table 5-11
North Shore Zoning Comparisons

Community	R1	R2	R3	Com.	Ind.	Mixed Use	Water	Total
Beverly	980	402	89	6	195	0	80	1752
Essex	0	0	0	0	0	2580	110	2690
Hamilton	1434	583	1305	0	0	0	157	3479
Manchester	1046	838	0	884	0	41	0	2809
Wenham	0	3370	0	4	0	0	141	3515
Danvers	169	0	0	0	0	0	256	425
Gloucester	182	0	0	0	78	0	0	260
Topsfield	0	0	119	0	0	0	0	119
Total	3811	5193	1513	894	273	2621	744	15049
Percent	25%	35%	10%	6%	2%	17%	5%	100%

Figure 5-7

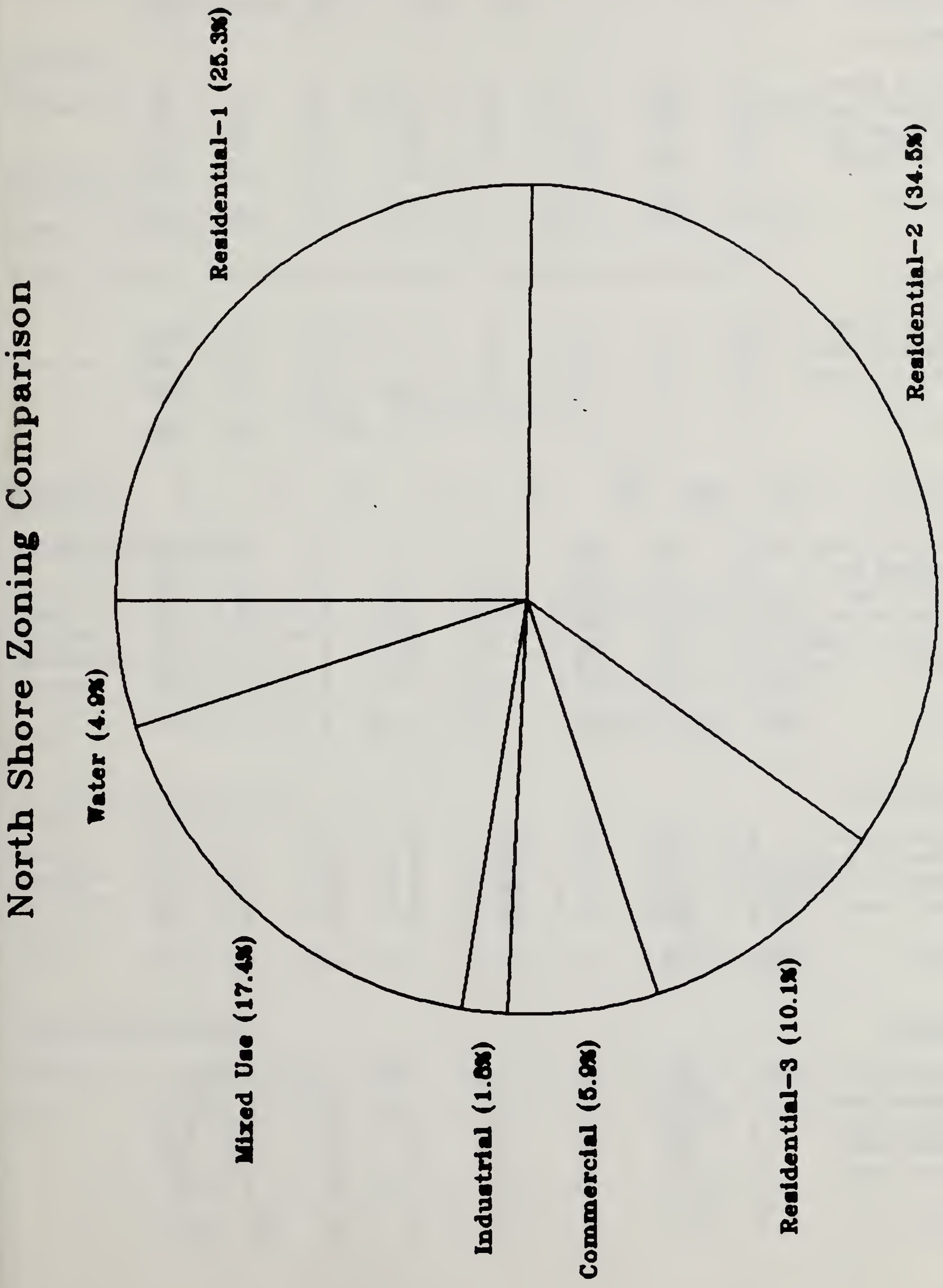

North Shore Zoning Comparison
Residential-1 (25.3%)
Residential-2 (34.5%)
Residential-3 (10.1%)
Commercial (5.9%)
Industrial (1.6%)
Mixed Use (17.4%)
Water (4.9%)

Table 5-12
North Shore Zoning Comparison by Town and Source

Community	R1	R2	R3	Com.	Ind.	Mixed Use	Water	Total
Beverly								
Essex River	0	89	0	0	0	0	0	89
Wenham Lake	43	260	0	6	158	0	80	547
Longham Res.	937	53	89	0	37	0	0	1116
Round Pond	0	81	0	0	0	0	0	81
Total *	980	402	89	6	195	0	80	1752
Essex								
Essex River	0	0	0	0	0	1831	110	1941
Gravelly Pond	0	0	0	0	0	10	0	10
Sawmill Brook	0	0	0	0	0	749	0	749
Total *	0	0	0	0	0	2580	110	2690
Hamilton								
Wenham Swamp	1023	140	358	0	0	0	0	1521
Longham Res.	0	0	241	0	0	0	0	241
Round Pond	0	0	103	0	0	0	28	131
Essex River	197	355	608	0	0	0	157	1317
Gravelly Pond	0	0	186	0	0	0	50	236
Hamilton East	403	316	424	0	0	0	78	1221
Total *	1434	583	1305	0	0	0	157	3479
Manchester								
Essex River	0	350	0	275	0	0	0	625
Gravelly Pond	0	33	0	147	0	0	0	180
Sawmill Brook	1046	488	0	609	0	41	0	2184
Round Pond	0	308	0	100	0	0	0	408
Total *	1046	838	0	884	0	41	0	2809
Wenham								
Wenham Lake	0	896	0	0	0	0	119	1015
Wenham Swamp	0	1809	0	4	0	0	0	1813
Longham Res.	0	810	0	0	0	0	22	832
Round Pond	0	293	0	0	0	0	0	293
Essex River	0	311	0	0	0	0	0	311
Total *	0	3370	0	4	0	0	141	3515

Table 5-12 continued ...

Danvers								
Putnamville R.	169	0	0	0	0	0	256	425
Topsfield								
Putnamville R.	0	0	119	0	0	0	0	119
Gloucester								
Sawmill Brook	182	0	0	0	78	0	0	260

* Totals do not include any overlaps of watersheds and aquifers.

Table 5-13
Zoning by Water Source

Community	R1	R2	R3	Com.	Ind.	Mixed Use	Water	Total
Essex River Subbasin								
Beverly	0	89	0	0	0	0	0	89
Essex	0	0	0	0	0	1831	110	1941
Hamilton	197	355	608	0	0	0	157	1317
Manchester	0	350	0	275	0	0	0	625
Wenham	0	311	0	0	0	0	0	311
Total	197	1105	608	275	0	1831	267	4283
Gravelly Pond Reservoir								
Essex	0	0	0	0	0	10	0	10
Hamilton	0	0	186	0	0	0	50	236
Manchester	0	33	0	147	0	0	0	180
Total	0	33	186	147	0	10	50	426
Hamilton East aquifer								
Hamilton	403	316	424	0	0	0	78	1221
Total	403	316	424	0	0	0	78	1221

Table 5-13 continued ...

Wenham Swamp Aquifer

Hamilton	1023	140	358	0	0	0	0	1521
Wenham	0	1809	0	4	0	0	0	1813
Total	1023	1949	358	4	0	0	0	3334

Longham Reservoir

Beverly	937	53	89	0	37	0	0	1116
Hamilton	0	0	241	0	0	0	0	241
Wenham	0	810	0	0	0	0	22	832
Total	937	863	330	0	37	0	22	2189

Putnamville Reservoir

Danvers	169	0	0	0	0	0	256	425
Topsfield	0	0	119	0	0	0	0	119
Total	169	0	119	0	0	0	256	544

Round Pond Reservoir

Beverly	0	81	0	0	0	0	0	81
Hamilton	0	0	103	0	0	0	28	131
Manchester	0	308	0	100	0	0	0	408
Wenham	0	293	0	0	0	0	0	293
Total	0	682	103	100	0	0	28	913

Sawmill Brook Watershed

Essex	0	0	0	0	0	749	0	749
Manchester	1046	488	0	609	0	41	0	2184
Gloucester	182	0	0	0	78	0	0	260
Total	1228	488	0	609	78	790	0	3193

Wenham Lake Watershed

Beverly	43	260	0	6	158	0	80	547
Wenham	0	896	0	0	0	0	119	1015
Total	43	1156	0	6	158	0	199	1562

CHAPTER 6

FINDINGS AND RECOMMENDATIONS

The previous chapters of this study have examined current and potential land uses in the North Shore Water Resource Study communities and the federal, state and local regulations to control such uses. Through such an analysis, areas of concern were identified for each community where drinking water supplies may be in jeopardy of contamination. In this chapter, methods to safeguard water quality for the future through overlay districts or more comprehensive bylaws and regulations are presented. Implementation of one or more of these methods by each of the study communities may help to secure ample and safe drinking water supplies for each community and the region as a whole. Existing state and federal regulations are compared to the potential controls communities can implement in Figure 6-1.

AREAS OF CONCERN

UNDERGROUND STORAGE TANKS

Findings

State and federal regulations require some tanks storing flammable liquids or compounds be registered with the local fire department and that periodic tests are conducted on tanks and pipings to assure their integrity before licenses are renewed. Storage facilities exempted from regulation are farm or residential tanks of 1,100 gallons capacity or less used for storing motor fuel for noncommercial purposes and tanks used for storing heating oil for consumptive uses on the premises where stored. Most communities keep some records of underground fuel storage, mostly limited to commercial storage of gas and diesel and oil burner permits. None of the communities maintains records on underground storage of hazardous materials. Although local protection measures may place a greater demand on local government, they are far less expensive than cleaning up or finding alternate water sources once municipal supplies become contaminated with fuels or hazardous materials which leak from underground tanks.

Recommendations

The communities should start with a comprehensive underground storage facility registration program. All tanks, regardless of size or content (including tanks containing hazardous wastes and chemicals) should be registered. As most communities have oil burner permits and licenses maintained by the fire departments, it would be reasonable to keep the coordination of these records in that office. Abandoned tanks should be removed or filled with an inert material according to 527 CMR 10.12(2).

Zoning Bylaws. It is recommended that communities amend their zoning bylaws to include a water resources overlay protection

Figure 6-1

POTENTIAL IMPACTS AND MANAGEMENT TECHNIQUES

REGULATIONS	POTENTIAL SOURCES OF CONTAMINATION							
	Underground Tanks	Wastewater	Road Salt	Leachate	Hazardous Wastes & Materials	Pesticides	Mining	Runoff & Erosion & Recharge
FEDERAL								
Resource Conservation & Recovery Act (RCRA)					●			
Federal Safe Drinking Water Act		●						
Superfund Amendments & Reauthorization Act (SARA)					●			
STATE								
Fire Prevention Regulations	●							
DEQE Solid Waste Regulations				●				
Hazardous Waste Management Act					●			
Pesticide Control Act						●		
Groundwater Discharge Regulations		●						
NPDES Surface Water Discharge Permits		●						
State Environmental Code (Title 5)		●						
Landfill Regulations				●				
LOCAL								
Water Resources Protection Overlay District	●	●	●	●	●		●	
Board of Health - Title 5 Supplements		●						
Wetlands Protection District		●	●			●	●	○
Underground Storage Tank Bylaw/Regulations	●				●			
Earth Removal Regulations							●	●
Household Hazardous Waste Collection Program		○		○	●	○		
Hazardous Materials Bylaw	●	○			●			
Road Salt Storage/Controlled Application Program			●					
Subdivision Regulation Amendment		○						●
Landfill Regulations				●				

● Contamination Control Measure

○ Indirect Contamination Control or Mitigation district which prohibits new underground fuel storage tanks in aquifer and watershed areas which are exempted by the state regulations. These include fuel oil tanks used for area heating on premises and residential or farm tanks for motor fuel storage less than 1,100 gallons. In the alternative, these requirements may also be adopted as part of a general bylaw on underground storage tanks.

General Bylaws/City Ordinances. Communities should adopt a general bylaw or city ordinance which would apply to all existing tanks throughout the community (including tanks not regulated under state or federal law). This bylaw should:

- require registration of all tanks;
- set specific tightness testing schedules for tanks exempted by CMR 9.00; and
- require tanks over twenty years of age to be removed from service unless an approved monitoring system is installed and maintained (see Appendix C3 for examples of the above bylaw sections).

These measures can be phased in over time, beginning with registration the first year and increasing the level of regulation in later years to include tightness testing and old tank removal.

Regulation of this bylaw can be the responsibility of the Board of Health, Board of Selectmen, City Council or the Fire Chief.

It is also recommended that copies of all permit applications be reviewed and commented on by the Fire Department, Board of Health, Conservation Commission and Water Department with recommendations in writing to the responsible board within 30 days. Enforcement measures, a schedule of fines and registration fees should also be included in this bylaw.

The communities should consider pooling their resources to implement such a bylaw. For instance, personnel and equipment needed for testing, monitoring and enforcement could be shared by the five communities.

WASTEWATER

Findings

Federal programs regulate wastewater discharges to surface waters and state programs regulate septic systems and discharges to groundwater. Local Boards of Health can also adopt regulations more stringent than the state regulations for septic systems. Beverly, Essex, Hamilton and Manchester have adopted amendments to Title 5 but they are not as comprehensive as they could be and do not address issues specific to their water supplies. Wenham has no local regulations.

Recommendations

Specific regulations concerning the siting, design, and maintenance of septic systems under Title 5, and their effectiveness, should be discussed among the committee members to determine those standards that would be most applicable to each community for adoption under the local health regulations. Below is a list of other regulations/restrictions that should be considered for adoption.

General recommendations include:

1. The conduct of a public information program on chemical septic-tank cleaners to deter the use of groundwater polluting compounds such as methlene chloride, orthodichlorobenzene, 1,1,1,-trichloroethane, and napthlene;

2. Implementation of a local or regional septic system inspection and maintenance program such as a requirement to inspect and pump a septic system prior to the sale/transfer of a property; and

3. Restrictions on the siting, use, and maintenance of wastewater package treatment plants.

Specific additions/changes to the local board of health regulations should include:

1. A maximum percolation rate of 2 minutes per inch shall be required to prevent the excessively rapid infiltration of leachate into the groundwater. (Title 5 sets a minimum percolation rate, but no maximum.)

2. All septic systems and leaching fields shall be set back a minimum of 150 feet from surface drinking water supplies. (Title 5 requires that septic systems have a minimum setback of 50 feet from surface water supplies and that leaching fields have a minimum setback of 100 feet from surface waters.)

3. Dewatered percolation tests will not be accepted as a basis for the allowable siting of a septic system.

4. Percolation tests during drought conditions will include the use of hydrogeologic indices or soil profile analysis to determine the high water table in non-drought conditions.

Finally, Title 5 and local supplemental regulations should be strictly enforced in the watershed and aquifer areas of the communities.

ROAD SALT

Findings

The major source of sodium in the environment comes from road salt applications to control ice and snow. Under the Safe Drinking Water Act (310 CMR 22.06), the EPA has set safe sodium levels in drinking water below 20 mg/l. Within the North Shore study area, Beverly and Manchester were required to notify customers of high sodium levels during at least one quarter in 1983, 1984 or 1985. Each town uses a different sand to salt application ratio and only Wenham has a restricted use policy throughout their town. None of the communities has regulations controlling road salt usage.

Recommendations

About the only way to protect water supplies from sodium contamination is to decrease or eliminate sodium use in the water supply area and control the storage of road salt. If salt piles must be located in the water supply area, then sand and salt piles should be completely covered, located on impermeable surfaces, and the sites should be properly graded with runoff-collection systems. Collected brine can be recycled. Loading areas should be protected from weather and sheds should be large enough to allow loading of trucks inside under cover. The state DPW has funds available for construction of salt sheds and containment areas. All communities with salt storage within the water study area have salt storage facilities.

Each town should reassess their sand:salt application ratio and practices. Equipment should be tested and spreaders should be calibrated at the start of each season. Spreaders should be equipped with ground speed controllers.

Communities should examine dump sites of salt laden snow and locate these outside water supply areas and away from town landfills.

The communities should work together to encourage the state DPW to designate sections of state roads through the water study areas as critical and encourage restricted salting practices on these roads.

In water supply areas with heavy residential concentrations, towns should work to educate residents to other forms of sodium contamination. Septic treatments, water softners and home use of road salts can all increase the sodium content in public water supplies.

Communities could also consider alternatives to sodium chloride in critical areas of the watershed/aquifer. One of the most viable alternatives is calcium magnesium acetate (CMA), which acts at about the same rate as sodium chloride and is as persistent, but CMA has no potential for harming drinking water supplies. CMA has the added benefit of being harmless to flora and fauna and is beneficial to soils. CMA costs more per pound than road salt but is environmentally safe and has no corrosive effects (in fact it is a corrosion inhibitor), therefore eliminating both the high expense of auto/highway corrosion repair and compensation for water supply damage attributed to road salt usage.

LEACHATE

Findings

State regulations control various aspects of new and expanded landfills including control of leachate. Two of the towns, Essex and Hamilton, have local landfill bylaws but these do not address leachate abatement.

Recommendations

Board of health regulations should require that all inactive landfills be properly closed and capped with impervious materials. Requirements should outline the type of cover to be used, allowed permeability of the cover material, seeding of the covered area, and grading and slope of the cover material. Guidelines for collection, removal, and treatment of leachate; gas venting, and duration of monitoring should also be included.

Post-closure groundwater and surface water monitoring and testing for contaminants and other chemical parameters should be required on a regular basis. A suggested time frame would be to require quarterly testing following the first year of closure, and semi-annually thereafter for a reasonable period as determined by the board of health. The communities also may want to invest in hydrogeologic studies to be assured that leachate is not moving toward nearby drinking water sources.

HAZARDOUS WASTE AND MATERIALS

Findings.

State and federal programs are attempting to regulate the handlers of hazardous materials and the generators of hazardous wastes. The state is also working to extend programs to assist with household hazardous waste concerns.

Recommendations.

Zoning Bylaws. The communities should adopt zoning overlay districts in the water study area, which would prohibit underground storage of hazardous materials.

General Bylaw. Communities should adopt a General Bylaw, or if the Board of Health is the emergency coordinator under SARA and Right to Know, then communities should adopt a Board of Health Regulation, which would require:

1. registration of all hazardous materials above a threshold quantity of 50 gallons liquid or 25 lbs. dry weight;
2. regulation of aboveground storage facilities;
3. regulation of underground storage facilities;
4. siting specifications; and
5. leak response plans.

A model bylaw and registration form are attached in Appendix C4.

Household Hazardous Wastes Collection Programs. Hamilton and Manchester should continue with their household hazardous waste collection program on at least an annual basis. Beverly, Essex and Wenham should develop such programs and apply for funding assistance if available from the state. Publicity for all collections should especially focus on aquifer and watershed protection districts and, where feasible, might include a door to door leaflet campaign within the water study area. There should also be a public education effort to discourage the improper disposal of household hazardous wastes and encourage the use of alternative, environmentally safe products. In order to cut costs, the five communities may also consider a joint household hazardous waste collection program on a semi-annual basis -- in the spring following "spring cleaning time" and in the late fall to collect leftover paints and fertilizers from summer home maintenance.

The communities should also consider a waste oil collection and recycling program, which could be operated in conjunction with the household hazardous waste program, or with the solid waste transfer station.

PESTICIDES

Findings

Federal programs and state programs modeled after the federal programs, regulate pesticide use and management. Although a number of cities and towns in Massachusetts have adopted measures that directly or indirectly prohibit the use of herbicides for right-of-way vegetation control, their legality is in question. The state Attorney General has disapproved local bylaws and ordinances where it appears that there is a preemption of FIFRA or the state Pesticide Control Act. A number of unresolved issues remain regarding this matter. The denial of a bylaw by the Attorney General in 1980 that was proposed by the Town of Wendell is now being litigated. (*Wendell* v. *Bellotti*, C.A. No. 15119, Franklin Superior Court).

Recommendations

Given the legal restraints to adopting pesticide control regulations at the local level, communities may want to focus more on monitoring the use of pesticides within their jurisdiction. Groundwater and surface waters in the vicinity of areas that are maintained through the application of pesticides, such as golf courses and other recreational fields and rights-of-ways, should be monitored on a regular basis to ensure that these water resources are not being contaminated. Communities could also demonstrate the proper application of household pesticides and recommend safer alternatives to very toxic products as part of a household hazardous waste reduction program.

MINING

Findings

There are no federal and state controls of mining. Some local controls exist but they do not address water quality concerns.

Recommendations

The most critical factor affecting the impact of excavation on groundwater is the thickness of the earth material, referred to as overburden, resting between the bottom of the pit and the seasonal high water table. This may affect the quality and quantity of the groundwater. Other communities in Massachusetts have adopted bylaws requiring between 4 and 30 feet of earth materials above the water table, with the majority in the 5 to 10 foot range. The permitted depth should be based on proposed use of the site after excavation and the measured seasonal high water table. This measurement should be determined through the observation of test borings during one recharge season -- usually during March, April, and May.

Restoration requirements to control resultant impacts from the alteration of slope and drainage patterns, and compaction should also be included in a local bylaw. The restoration plan should show the final contours of the site after the completion of excavation. Slopes should be limited to at most, 2:1 (50%), although 4:1 (25%) is preferred and should be required in sensitive areas. Areas that have been compacted by heavy machinery should be scarified to a depth of at least 3 feet. Surface drainage should not be altered -- the same quantity of runoff that left the site before excavation should leave the site afterwards. Topsoil removed from excavated areas should be stockpiled and spread over the restored site, and vegetation should be reestablished. This will facilitate maximum recharge rates.

In an application for a permit for earth removal, information on the proposed depth of excavation and the elevation of the annual high water table, as determined by the test pits and soil borings monitored for at least one year, or during one high water season, should be required.

The bylaw could also regulate ancillary activities, such as vehicle maintenance and storage of lubricants and other chemicals associated with the mining operation.

ZONING

The existing zoning of the Water Resources Study Area is predominantly residential, but there are nearly 900 acres zoned commercial, 300 acres zoned industrial and 2,500 acres which have no specific use designation, which allows for any type of use. Together, these zoning districts represent 25 percent of the water resources study area. Within these districts, uses with significant potential water quality impacts are permitted. Only two of the communities have adopted overlay zoning to protect water supplies.

A summary of the significant findings and recommendations for each community follows.

- Beverly

  Findings. Beverly's Watershed Protection District covers only a portion of the water study area around Wenham Lake.

  Recommendations. The city should extend the protection of the existing watershed overlay district to the remaining portion of the Wenham Lake Watershed and to the Longham Reservoir Watershed in order to protect Beverly's water supplies directly. This measure would reduce the threat of contamination of the city's water supplies due to incompatable land uses in the watershed area.

- Essex

  Findings. The town's zoning bylaw does not delineate separate districts for various uses such as residence, commercial and industry. Therefore, any use which conforms with zoning requirements may be located anywhere within the town, including the water resources study area.

  Recommendations. The town should amend its zoning bylaw by adding a water resources protection overlay district. The boundaries of the overlay district should include the areas of contribution (DEQE Zone II) related to the town's wells, as determined by hydrogeologic studies. The district would classify land uses as either permitted, special permit, or prohibited, as set out in the model bylaw in Appendix C1.

- Hamilton

  Findings. The town has adopted a Groundwater Protection District which covers the two aquifer areas but does not include portions of the watershed areas of Round Pond, Gravelly Pond, Longham Reservoir, and Chebacco Lake. Further, the district's regulations do not include a full range of permitted uses for the District.

  Recommendations. The existing Groundwater Protection Overlay District should be amended to include a more comprehensive set of use regulations. These should provide for uses which are permitted, allowed by special permit, and prohibited, according to the degree of threat to water supplies. Recommended use regulations are included in the model bylaw in Appendix C1. The boundaries of the district should also be expanded to cover the watershed areas of Round Pond, Gravelly Pond, Longham Reservoir, and Chebacco Lake.

- Manchester

  Findings. The water study area of Manchester contains six differently zoned areas, including an industrial and a commercial district.

Recommendations. The town should amend its zoning bylaw by adding a water resources protection overlay district. The boundaries of the overlay district should include the areas of contribution (DEQE Zone II) related to the town's wells, as determined by hydrogeologic studies. the protection district should also include the portions of the Round Pond and Gravelly Pond watersheds in manchester. The district would classify land uses as either permitted, special permit, or prohibited, as set out in the model bylaw in Appendix C1.

- Wenham

Findings. Wenham has a defined water resources study area but does not have a water resources overlay protection district.

Recommendations. The town should adopt a water resources overlay protection district as an amendment to the zoning bylaw. The boundaries of the district should include the aquifer areas delineated by hydrogeologic studies as well as the watershed areas of Wenham lake, Round Pond, and Longham Reservoir. The bylaw would classify all uses as permitted, special permit, or prohibited according to the degree of threat to water quality. Recommended use regulations are included in the model bylaw in Appendix C1.

- Danvers/Topsfield

The watershed of Putnamville Reservoir, which supplies water to the Salem and Beverly Water Supply Board, is entirely within Danvers and Topsfield. The zoning of the 544 acre watershed is residential, with no overlay protection. The Intercommunity Water Resources Committee should explore the possibility of securing the cooperation of Danvers and Topsfield to apply overlay protection zoning to these areas, and to notify the Committee of significant development proposals there.

SUBDIVISION REGULATIONS

Findings. Subdivision regulations for the North Shore communities contain provisions for the regulation of surface drainage and runoff, but there are no provisions which directly take groundwater into consideration.

Recommendations. The planning boards should amend the subdivision regulations by adding a provision which allows the boards to require information on groundwater resources, impacts, and mitigation measures. This provision would be optional and applied in appropriate cases at the discretion of the planning boards. It should allow the boards to require such information as water table elevations, direction of groundwater flow, nutrient loading, and impacts on aquifers or recharge areas for public or private water supplies. Mitigation measures to be analyzed may include open and closed drainage systems, oil and grease separators, and detention basins for contaminant removal.

The amendment should allow the boards to require appropriate mitigation measures to protect groundwater quality and quantity.

A model subdivision regulation amendment is included in Appendix C2.

REGIONAL COORDINATION

Findings. The Intercommunity Water Resources Committee has made significant progress in initiating a regional approach to water resources protection. As this study has shown, the majority of the water resources are "intercommunity" in their locations or patterns of use. Long-term coordinated management and protection of these resources is necessary to ensure quality drinking water in the future.

Recommendations. In order to strengthen the Intercommunity Water Resources Committee, it is recommended that the communities adopt a Memorandum of Understanding (MOU) to define the Committee's responsibilities and formalize its role in coordinating the management and protection of the region's water resources. The MOU would help to ensure long term continuity in the efforts of the five communities to coordinate their water management activities, and give the Committee a well defined role as an advisor to the chief elected officials of the communities. A model MOU is included in Appendix E.

APPENDICES

APPENDIX A
Underground Fuel Oil Storage Tanks

Beverly Fuel Oil Storage Permits In Water Study Area

Name, Address	Tank Size (gallons)	Tank Type
Star Market, 69 Dodge Street	5,000	Steel
Zayre, 71 Dodge Street	5,000	Fiberglass
, 35 Arlington Ave.	?	?
, 38 Arlington Ave.	500	?
Bev. Salem Water Supply Brd, Arlington	1,000	?
Sabatini and Sons, 600 Cabot Street	1,000	?
I.F. Gould, 621 Cabot Street	1,550	Steel
Brown School (Bass River Condos) 30 Conant Street	4,000	Steel
2nd Congregational Church, 35 Conant Street	2,000	Steel
Carlson Assoc., 107 Dodge Street	1,000	Steel
David Sabatini, 299 Dodge Street	1,000	Steel
Donald Mitchell, 2 Enon Street	500	Steel
Gibbs Oil Div. of BP, 38 Enon Street	500	Steel
Sun Oil Co., 44 Enon Street	550	Steel
Gibbs Oil Co. Station, 74 Enon Street	500	Steel
Hillsmor Construction Co.		
1 Fieldstone Lane	500	Steel
2 Fieldstone Lane	500	Steel
3 Fieldstone Lane	500	Steel
4 Fieldstone Lane	500	Steel
5 Fieldstone Lane	500	Steel
6 Fieldstone Lane	500	Steel
7 Fieldstone Lane	500	Steel
8 Fieldstone Lane	500	Steel
9 Fieldstone Lane	500	Steel
10 Fieldstone Lane	500	Steel
11 Fieldstone Lane	500	Steel
Lawrence Cann, 20 Frankwood Avenue	500	Steel
Parkwood Construction Co.		
1 Gateway Lane	500	Steel
4 Gateway Lane	500	Steel
6 Gateway Lane	500	Steel
7 Gateway Lane	500	Steel
8 Gateway Lane	500	Steel
9 Gateway Lane	500	Steel
10 Gateway Lane	500	Steel
11 Gateway Lane	500	Steel
13 Gateway Lane	500	Steel
16 Gateway Lane	500	Steel
18 Gateway Lane	500	Steel
24 Gateway Lane	500	Steel
25 Gateway Lane	500	Steel
Beverly Farms School, 66 Haskell Avenue	5,000	Steel
Paul Weir, 30 Hathaway	2,000	Steel
Ambrefi, 7 Hickory Lane	1,000	Steel

APPENDIX A continued...

Parkwood Construction		
97 Hull St.	500	Steel
101 Hull St.	500	Steel
103 Hull St.	500	Steel
105 Hull St.	500	Steel
Margaret McKean, 95 Hull St.	3,000	Steel
Parkwood Construction Co., 95 Hull St.	500	Steel
Charles Driscoll 95 Hull St.	2,000	Steel
	2,000	Steel
	2,000	Steel
Azor Roundy, 64 Hull St.	1,000	Steel
Robert Marshall, 61 Hull St.	1,000	Steel
Warren Tibbetts, 61 Hull St.	275	Steel
Arkin, 44 Hull St.	275	Steel
Kilham, 42 Hull St.	275	Steel
Parkwood Construction Co., 93 Hull St.	500	Steel
Centerville Elem. School, Hull St.	10,000	Steel
Hillsmor Construction Co.		
25 Kennell Hill Road	500	Steel
27 " " "	500	Steel
29 " " "	500	Steel
30 " " "	500	Steel
32 " " "	500	Steel
33 " " "	500	Steel
35 " " "	500	Steel
36 " " "	500	Steel
51 " " "	500	Steel
75 " " "	500	Steel
Parkwood Construction Co.		
07 Kennell Hill Road	500	Steel
12 " " "	500	Steel
13 " " "	500	Steel
14 " " "	500	Steel
27 " " "	500	Steel
28 " " "	500	Steel
29 " " "	500	Steel
30 " " "	500	Steel
30-B " " "	500	Steel
34 " " "	500	Steel
55 " " "	500	Steel
56 " " "	500	Steel
57 " " "	500	Steel
72 " " "	500	Steel
73 " " "	500	Steel
74 " " "	500	Steel
76 " " "	500	Steel
77 " " "	500	Steel
Dr. Ralph Stone, 15 Lakeview Ave.	1,000	Steel
Boyd Roberts		
45 Neptune Street	1,000	Steel
49 Neptune Street	500	Steel
Hi Du Way Greenhouse, 45 Neptune St.	500	Steel
Hammond, Neptune Street	550	Steel
Phillip Carlman, 21 Neptune Street	1,000	Steel

APPENDIX A continued...

Edward Winslow, 6 Neptune Street	1,000	Steel
Ouellette, Neptune Street	500	Steel
Anchorage North, 7 Pershing Ave.	500	Steel
	500	Steel
Thomas Wigglesworth, Preston Place	2,000	Steel
Salem Water Board, Salem Road	2,000	Steel
Arpin Circle Inc., 5 Scenna Road	275	Steel
James Cooper, 3 Scenna Road	275	Steel
Warren Bennett, Jr., 4 Thaxton Road	2,000	Steel
Columbo DiStefano, 9 Wedgemere Road	275	Steel
Joseph Castilluci, 7 Wedgemere Road	275	Steel
Gunard Manufacturing Co., Beverly Airport	1,000	?
	1,000	
	500	?
	500	?
GTE, Beverly Airport	2,000	?
	5,000	?
North Atlantic Air, Inc. Beverly Airport	2,000	?

Hamilton Fuel Oil Storage Permits In Water Study Area

Cutler School, Asbury Street	?	?
Paul Fasciano, 530 Essex	?	?
Laurence Galante, 430 Chebacco	2,000	Steel
	2,000	Steel
	2,000	?
Ham Junior High, Union Street	8,000	?
	8,000	Steel
P.B. Johnson, 453 Essex	1,000	?
Michael Talbot, 359 Forest Street	500	Steel
Timpson, Partrigeberry	2,000	Steel
David & Sandra Tonneson, Lot 4, Woodbury	1,000	Steel
William Towne, 313 Essex Street	550	Steel
Welch & Lamson, 305 Willow	20,000	Fiberglass
	20,000	Fiberglass
Bruce Young, Old Cart Road	1,000	Steel

Manchester Fuel Oil Storage Permits In Water Study Area

Axel Magneson Inc. Greenhouse, 33 Vine St.	2,500	Steel
Butler Oil, 43 Pleasant Street	1,600	Steel
Country Traditions Furniture, 66 Summer St. (this building is being converted to low and moderate income housing)	3,000	Steel
Eleanor Hoare, 119 Pleasant Street	500	Steel
Richard Lations, 24 Loading Place Road	500	Steel
Harry Lattanzi, 19 Forest Lane	500	Steel
Mrs. Dean Lynch, Corner Lincoln & School	1,000	Steel
Manchester High School, Lincoln Street	12,000	Steel
Manchester Fire Department, 12 School St.	2,000	Steel
Memorial Elementary School, Lincoln St.	10,000	Steel

APPENDIX A continued...

Development on Moses Hill Road (tanks registered under developer and not by current resident)	500	Steel
	500	Steel
	500	Steel
	500	Steel
	500	Steel
New England Telephone, 52 Summer Street	1,000	Steel
	1,000	Steel
Greg Nichols, 45 Forest Street	500	Steel
Phillip Parsons, 120 School	500	Steel
Sacred Heart School, 62 School	6,200	Steel
Bradford Silsby, 26 Loading Place Road	500	Steel
Adam Stasiak, 3 Pulaski Drive	550	Steel
Benjamin Stasiak, 9 Pulaski Drive	1,500	Steel
Unknown, 73 Pleasant Street	550	Steel
Unknown, 73 Pleasant Street	550	Steel
Peter Ward, 173 School	500	Steel

Wenham Fuel Oil Storage Permits In Water Study Area

1 Romona Way	1,000	Steel
11 Woodside Lane	2,000	Steel
15 William Fairfield Drive	2,000	Steel
18 Kimball Avenue	?	Steel
255 Grapevine Road	8,000	Steel
	10,000	Steel
26 Monument Street	?	Steel
272 Grapevine Road	1,000	Steel
300 Main Street	1,000	Steel
38 William Fairfield Drive	1,000	Steel
50 Monument Street	2,000	Steel
67 Dodges Row	2,000	Steel
Dane's Way	1,000	Steel
Middle School	?	?

APPENDIX B
RCRA Waste Codes

The Resource Conservation and Recovery Act (RCRA) requires EPA to identify hazardous wastes that pose a hazard to human health and the environment, if improperly managed, and to regulate these wastes by licensing generators and handlers of these materials. The Agency has established regulatory levels of hazardous wastes based on their potential to contaminate drinking water wells if the wastes are released into the environment. Chemicals generated or handled in the North Shore Water Study area are listed below.

CODE	DESCRIPTION
D001	A solid waste that exhibits the characteristics of ignitability, but is not listed as a hazardous waste below.
D002	A solid waste that exhibits the characteristics of corrosivity, but is not listed as a hazardous waste below.
D003	A solid waste that exhibits the characteristics of reactivity, but is not listed as a hazardous waste below.
D004	Arsenic
D008	Lead
F001	The following spent halogenated solvents used in degreasing: Tetrachlorethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons, all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F002	The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobezene, trichlorofluoromethane, and 1,1,2-trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F003	The following spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

APPENDIX B continued . . .

CODES	DESCRIPTION
F005	The following spent non-halogenated solvents: Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) Sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.
F007	Spent cyanide plating bath solutions from electroplating operations.
F008	Plating bath residues from the bottom of plating baths from electroplating operations where cyanides are used in the process.
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process.
P015	Beryllium dust or Beryllium
P029	Copper Cyanide
P030	Cyanides (soluble cyanide salts), not otherwise specified
P073	Nickel carbonyl or (t-4)-nickel carbonyl
P074	Nickel Cyanide
P098	Potassium Cyanide
U013	Ethyl ester 2-propenoic acid
U044	Chloroform or Trichloromethene
U112	Ethyl ester acetic acid or Ethyl acetate
U122	Formaldehyde
U134	Hydrofluoric acid or Hydrogen fluoride
U151	Mercury
U154	Methanol or Methyl alcohol
U159	2-Butanone or Methyl ethyl ketone (MEK)
U165	Napthalene
U169	Nitrobenzene
U185	Pentachloronitro-benzene and Pentachloronitrobenzene (PCNB)
U187	N-(4-ethoxyphenyl)-acetamide or Phenacetin
U210	Tetrachloroethene and Tetrachloroethylene
U220	Methylbenzene or Tolulene
U226	Methylchloroform or 1,1,1-trichloroethane
U227	2-ethoxy-ethanol, or 1,1,2-trichloroethane
U239	Dimethylbenzene or Xylene

APPENDIX C
Bylaws and Regulations

1. Water Resources Protection District
2. Subdivision Regulation Amendments
3. Underground Storage Tank Bylaw Sections
4. Hazardous Materials By-Law
5. Earth Removal Bylaw Amendment

WATER RESOURCES PROTECTION DISTRICT

1. Purpose of District

The purpose of this Water Resources Protection District is:

A. to promote the health, safety, and general welfare of the community;

B. to protect, preserve and maintain the existing and potential groundwater supply and groundwater recharge areas within the town;

C. to preserve and protect present and potential sources of water supply for the public health and safety;

D. to conserve the natural resources of the town;

E. to prevent blight and the pollution of the environment.

2. Scope of Authority

The Water Resources Protection District is considered as overlying other zoning districts. No uses not permitted in the portions of the districts so overlaid shall be permitted in this district.

3. Definitions

Animal Feedlot: A plot of land on which 25 livestock or more per acre are kept for the purposes of feeding.

Aquifer: Geologic formation composed of rock or sand and gravel that contains significant amounts of potentially recoverable potable water.

Groundwater: All the water found beneath the surface of the ground. In this bylaw the term refers to the slowly moving subsurface water present in aquifers and recharge areas.

Impervious Surface: Material on the ground that does not allow surface water to penetrate into the soil.

Leachable Wastes: Waste materials including solid wastes, sewage, sludge, and agriculture wastes that are capable of releasing water-borne contaminants to the surrounding environment.

Mining of Land: The removal or relocation of geologic materials such as topsoil, sand and gravel, metallic ores, or bedrock.

Recharge Areas: Areas composed of permeable stratified sand and gravel and certain wetlands that collect precipitation or surface water and carry it to aquifers.

Solid Wastes: Useless, unwanted, or discarded solid material with insufficient liquid content to be free flowing. This includes but is not limited to rubbish, garbage, scrap materials, junk, refuse, inert fill material and landscape refuse.

4. Establishment and Delineation of Water Resources Protection District

For the purposes of this district, there are hereby established within the town certain aquifer protection areas, consisting of aquifers and/or aquifer recharge areas, which are delineated on a map at a scale of 1 inch to ___ feet entitled "Water Resources Protection Areas, Town of _________" This map is hereby made a part of this district and of the town zoning bylaw and is on file in the Office of the Town Clerk.

Where the bounds are delineated are in doubt or in dispute, the burden of proof shall be upon the owner(s) of the land in question to show where they should properly be located. At the request of the owner(s) the town may engage a professional geologist or soil scientist to determine more accurately the location and extent of an aquifer or recharge area, and may charge the owner(s) for all or part of the cost of the investigation.

5. Use Regulations

Within the Water Resources Protection District the following regulations shall apply:

A. The following uses are permitted within the Water Resources Protection District,, subject to s. B, provided that all necessary permits, orders, or approvals required by local, state, or federal law are also obtained:

(i) conservation of soil, water, plants and wildlife;

(ii) outdoor recreation, nature study, boating, fishing, and hunting where otherwise legally permitted;

(iii) foot, bicycle and/or horse paths and bridges;

(iv) normal operation and maintenance of existing water bodies and dams, splash boards, and other water control, supply and conservation devices;

(v) maintenance, repair and enlargement of any existing structure provided there is no increase in impermeable pavement;

(vi) residential development, if permitted in the underlying district, provided that no more than 15 percent of a building lot (including the portion of any new street abutting the lot) is rendered impervious.

(vii) farming, gardening, nursery, conservation, forestry, harvesting and grazing provided that fertilizers, herbicides, pesticides, manure and other leachable materials are not stored outdoors.

B. The following uses are prohibited:

(i) disposal of solid wastes, other than brush and stumps;

(ii) storage of petroleum or other refined petroleum product except within buildings which it will heat;

(iii) the disposal of liquid or leachable wastes, except residential waste disposal systems;

(iv) the rendering impervious of more than 15% of any lot;

(v) industrial uses which discharge process wastewater on-site;

(vi) storage of road salt or other deicing chemicals;

(vii) dumping of snow containing deicing chemicals which is brought in from outside the district;

(viii) animal feedlots;

(ix) the storage of uncovered manure;

(x) mining of land except as incidental to a permitted use;

(xi) the storage or disposal of hazardous wastes, as defined by the Hazardous Waste Regulations promulgated by the Hazardous Waste Board, the Water Resources Commission, and the Division of Water Pollution Control under the provisions of Sections 27 (8), 52, 57, and 58 of Chapter 21 of the General Laws.

(xii) Automotive service and repair shops, junk and salvage yards.

C. The following uses are permitted by Special Permit, subject to the approval of the Zoning Board of Appeals under such conditions as they may require and also subject to s. B:

(i) the application of pesticides for non-domestic or non-agricultural uses provided that all necessary precautions shall be taken to prevent hazardous concentrations of pesticides in the water and on the land within the Aquifer Protection District as a result of such application. Such precautions include, but are not limited to, erosion control techniques, the control of runoff water (or the use of pesticides having low solubility in water), the prevention of volatilization and redeposition of pesticides and the lateral displacement (i.e. wind drift) of pesticides;

(ii) the application of fertilizers for non-domestic or non-agricultural uses provided that such application shall be made in such a manner as to minimize adverse impacts on surface and groundwater due to nutrient transport and deposition and sedimentation;

(iii) those commercial and industrial activities permitted in the underlying district with a site plan review to prevent compaction and siltation, loss of recharge, exfiltration for sewer pipes and contamination by oil, chemicals, nutrients, etc.

D. Procedures for Issuance of Special Permit

1. Each application for a special permit shall be filed with the Zoning Board of Appeals and shall be accompanied by ______ copies of the plan.

2. Said application and plan shall be prepared in accordance with the data requirements of the proposed development, (e.g., site plan review, erosion and sedimentation control plan, etc.)

3. The Zoning Board of Appeals shall refer copies of the application to the Board of Health, Planning Board, the Conservation Commission and Town Engineer/Department of Public Works, which shall review, either jointly or separately, the application and shall submit their recommendations to the Zoning Board of Appeals. Failure to make recommendations within 35 days of the referral of the application shall be deemed lack of opposition.

4. The Zoning Board of Appeals shall hold a hearing, in conformity with the provisions of G.L. ch. 40A, s. 9, within 65 days after the filing of the application and after the review by the town/boards/departments.

   Notice of the public hearing shall be given by publication and posting and by first-class mailings to "parties in interest" as defined in G.L. ch. 40A, s. 11. The decision of the Zoning Board of Appeals and any extension, modification or renewal thereof, shall be filed with the Zoning Board of Appeals and Town Clerk within 90 days following the closing of the public hearing. Failure of the special permit granting authority to act within 90 days shall be deemed as a granting of the permit. However, no work shall commence until a certification is recorded as required by said s.11.

5. After notice and public hearing, and after due consideration of the reports and recommendations of the boards/departments, the Zoning Board of Appeals may grant such a special permit provided that it finds that the proposed use:

   (a) is consistent with the purpose and intent of this bylaw and will promote the purposes of the Water Resources Protection District,

   (b) is appropriate to the natural topography, soils, and other characteristics of the site to be developed;

   (c) will not, during construction or thereafter, have an adverse environmental impact on the aquifer or recharge area; and

   (d) will not adversely affect an existing or potential water supply.

Subdivision Regulation Amendments

Preliminary Plan

The Board may require that the following be submitted where such information is necessary to evaluate the plan because of special circumstances of the proposal or its location including, but not limited to, proximity to aquifers, groundwater recharge areas, or public water supply wells:

a. Location of aquifers or recharge areas for existing or potential drinking water supplies.

b. Maximum groundwater table elevation and direction and velocity of groundwater flow.

c. Projection of nutrient loading (nitrate-nitrogen concentrations) in groundwater downgradient of the subdivision in the water resources protection district.

d. Analysis of open and closed drainage system alternatives, examining effects upon the recharge of aquifers and the quality of the groundwater.

Required Improvements

The Board may require that the following measures be taken because of special circumstances of the proposal or its location including, but not limited to, proximity to aquifers, groundwater recharge areas, or public water supply wells:

(1) Design and construction shall reduce, to the extent possible, the following:

- dimensions of paved areas
- encroachment within any wetland or floodplain
- volume of cut and fill
- area over which vegetation will be distributed
- extent of waterways altered or relocated

(2) Pollution control devices, including provisions for containinant removal employing detention basins subsurface drains or perforated risers, oil and grit separator catch basins, and other appropriate devices.

(3) Measures to restrict nutrient loading in down gradient groundwater to a maximum of five milligrams per liter (5 mgl) nitrate-nitrogen.

Underground Storage Tank Bylaw Sections

Registration

Article : Will the Town vote to amend the General Bylaws by adding thereto the following new bylaw:

From after January 1, 1989, any person who owns, leases, or otherwise controls any parcel of land wherein an underground storage tank or container has been or will be installed shall register such tank or container with the Fire Chief.

As part of the registration process such person shall furnish to the Fire Chief evidence, deemed sufficient by him, to establish the date of installation of said tank or container. If such evidence is not furnished the tank or container shall be presumed to have been installed twenty years prior to the effective date of this bylaw. Tanks which are not registered as provided herein shall be tested immediately upon discovery at the owner's expense. The method of testing must be approved in advance by the Fire Chief.

Tightness Testing

All steel tanks, having a capacity of greater than three hundred (300) gallons of liquid hazardous material, shall be subject to one of the following tests at three (3) year intervals, and annually after ten (10) years, or if evidence of installation date is not available; a five (5) pounds per square inch air pressure test performed on an empty tank or any other testing system approved in advance by the Board of Health or the Chief of the Fire Department. Certifications of testing shall be submitted to the Board of Health and the Chief of the Fire Department. All tanks failing the test shall be disposed of under the direction of the Board of Health or the Chief of the Fire Department.

Removal of Aged Tanks

No storage facility solely used for single or two-family residential consumptive use on the premises shall remain underground for a period in excess of twenty (20) years from the date of installation, unless such storage facility shall satisfy one of the following two options: (a) the installation and maintenance of an approved monitoring system installed by a qualified person; or (b) the installation of an approved double-walled tank with interstitial space monitoring system and liquid removal port. If no substantial date of installation has been supplied, the tank shall be presumed to have been installed 20 years prior to the effective date of this bylaw.

HAZARDOUS MATERIALS BY-LAW

SECTION 1: HAZARDOUS MATERIALS

SUBSECTION 1: AUTHORITY

This By-Law is adopted by the Town of Canton under its home-rule powers, its police powers to protect the public health and welfare, and its authorization under Massachusetts General Laws, Chapter 40, Section 21.

SUBSECTION 2: PURPOSE

This By-Law is intended to protect the public health, safety and welfare, and the environment; as well as preserve and maintain the existing and potential groundwater supply, groundwater recharge areas, and surface waters within the Town from contamination with hazardous materials.

SUBSECTION 3: DEFINITIONS

The following definitions shall apply in the interpretation and implementation of this By-Law.

Hazardous Materials means a product or waste or combination of substances which because of quantity, concentration, or physical or chemical, or infectious characteristics may reasonably pose, in the determination of the enforcing authority, a substantial present or potential hazard to the human health, safety, or welfare, or the environment when improperly treated, stored, transported, used or disposed of, or otherwise managed. Any substance which may create a special hazard in the event of a spill, leak, fire, or exposure; and all substances deemed a hazardous waste in Massachusetts General Laws, Chapter 21C shall also be considered a hazardous material for the purpose of the By-Law.

Contingency Plan means a document setting an organized planned, and coordinated course of action to be followed in case of fire, explosion, or release of hazardous materials which could threaten public health, safety, or welfare, or the environment.

Discharge means the disposal, deposit, injection, dumping, spilling, leaking, incineration, or placing of any hazardous material into or on any land or water so that such hazardous material or any constituent thereof may enter the environment

SUBSECTION 3: DEFINITIONS CONTINUED

Materials Safety Data Sheet means the form containing data on physical characteristics, flammability, explosivity, reactivity, and the health and safety hazards of specific chemicals, as well as information relative to procedures recommended for spills and leaks of specific chemicals and special protections and precautions to be taken in the handling of specific chemicals.

Reportable Discharge means all discharge greater than three gallons liquid volume or five pounds dry weight, or any discharge which would potentially threaten the public health and safety or the environment by entering surface water, groundwaters, or water recharge areas, or by emitting toxic fumes or gases into the air. Discharges which are in compliance with all Federal, State, and local regulations, or which are permitted by governing Federal, State, or local agencies are not considered reportable discharges.

SUBSECTION 4: SEVERABILITY

Each provision of this By-Law shall be construed as separate to the end, that if any provision, or sentence, clause or phrase thereof, shall be held invalid for any reason, the remainder of that section and all other sections shall continue in full force and effect.

SUBSECTION 5: HAZARDOUS MATERIALS NOT SUBJECT TO REGULATION BY THIS BY-LAW

The following materials are not within the scope of authority of this By-Law:

(1) Domestic Sewage
(2) Household waste including garbage, trash and septage from single and multiple residences, hotels and motels.
(3) Wastes generated from the growing of agricultural crops and the raising of animals, including manure which are returned to the soil as fertilizer.

SUBSECTION 6: REGISTRATION REQUIREMENTS

Every owner, or operator of a commercial or industrial establishment (including municipal, state, and federal operations) which stores, transports, uses, handles, or otherwise manages hazardous materials (excluding fuel oil stored for the purpose of heating buildings located on site) totaling more than fifty gallons liquid volume or twenty-five pounds dry weight shall register with the Board of Health.

SUBSECTION 6: CONTINUED

Registration includes the following:

(1) Submission of a map or written description locating areas where hazardous materials are stored, handled, or in use, specifying approximate average quantities of materials in each location and the special handling required in a fire, leak, spill or exposure. Areas must also be identified which store emergency equipment including medical supplies, along with a brief description of the capabilities of the equipment.

This map or written description must also be posted in one of the following on site locations: (a) Guard Shack, (b) Fire Alarm Box, (c) Sprinkler Riser, (d) other location acceptable to the Head of the Fire Department. The location of this posting must be specified during registration.

(2) Submission of names, addresses, and telephone numbers of all qualified "Emergency Coordinators" who are individuals identified by owners or operators of commercial or industrial establishments which must register in accordance with this By-Law "Emergency Coordinators" must be knowledgeable in the types of hazardous materials used at the establishment, proper storage and handling of those materials, familiar with the establishments emergency contingency plan, and authorized as on-site coordinator in the event of an emergency.

(3) Keep on file at all times in an on-site location known and accessible to all "Emergency Coordinators", Materials Safety Data Sheets on all hazardous materials manufactured, stored, or used at the establishment. These Materials Safety Data Sheets must be available to the Board of Health and the Head of the Fire Department during routine inspections, investigations, and in the event of an emergency.

(4) Keep on file at all times in an on-site location known and accessible to all "Emergency Coordinators" an Emergency Contingency Plan which identifies "Emergency Coordinators" and details the area where and ways in which an emergency could come about, the techniques and procedures to be used for prevention and control of such emergencies, the emergency equipment available on-site, outside agencies and organizations who should be notified and/or may provide services in an emergency, an evacuation plan for personnel, and an inventory of the types, approximate quantities, and method of storage, transportation, and disposal of all hazardous materials.

SUBSECTION 6.1 EFFECTIVE DATE OF REGISTRATION REQUIREMENTS

(A) Registration required by Section 6 shall be initially submitted by September 1, 1983 and annually thereafter within thirty days of January 1 each year. Records required in Subsection to be kept on file at each establishment should be updated as frequently as necessary to ensure proper handling of hazardous materials and adequate procedures to minimize emergencies and the damage which would result from such emergencies.

(B) Owners and operators of commercial and industrial establishments who have not previously registered in accordance with Subsection 6 shall, if they meet registration requirements register initially within thirty days of meeting such requirements and thereafter within thirty days of January 1 each year.

SUBSECTION 6.2 UPDATING OF REGISTRATION INFORMATION

All information required under Subsection 6 of this By-Law must be kept current to reflect substantial changes in quantities or types of hazardous materials on-site.

SUBSECTION 7: HAZARDOUS MATERIALS GENERALLY

All hazardous materials within the Town of Canton must be stored, handled, transported and used in such a way as to minimize discharges and to ensure maximum protection of the environment and the public health, safety and welfare.

SUBSECTION 7.1:

All commercial and industrial establishments (including municipal, state, and federal operations) must provide adequate employee training programs to ensure proper use, storage, transportation and handling of hazardous materials.

SUBSECTION 7.2

Owners and operators of establishments registered in accordance with Subsection 6 of this By-Law must keep sufficient records to detect significant loss of hazardous materials and provide best estimates of quantities of hazardous materials on-site.

SUBSECTION 7.3

All locations where hazardous materials are stored or used in quantities that could cause a substantial hazard in the event of a spill, leak, fire, or exposure, shall be designated with legible warning signs of bright yellow, or other equally conspicuous color, indicating the potential danger and how to overcome or avoid such danger.

SUBSECTION 7.4

All hazardous materials shall be held in product tight containers. All containers of hazardous materials which permit leakage or spillage shall be disposed of or repaired to its original product tight state.

SUBSECTION 7.5

Every owner of a commercial or industrial establishment (including municipal, state, or federal operations) shall comply with all Federal, State, and Municipal Laws and Regulations relative to Hazardous Materials.

SUBSECTION 8: ABOVEGROUND STORAGE OF HAZARDOUS MATERIALS

(A) Aboveground containers of hazardous materials shall be kept in an orderly manner, shall be adequately marked to identify the hazard, and shall be stored on a surface impervious to the material being stored. The storage area shall be enclosed by a permanent dike of impermeable construction. The volume of the area enclosed by the dike shall be equal to or greater than the capacity of the containers within the dike.

(B) There shall be no storage of incompatible chemicals (those which react with one another to create a special hazard) in the same area.

(C) Drainage and ventilation of storage areas containing hazardous materials shall be constructed and maintained so as to control spills, fumes, noxious gases and other potential sources of contamination

SUBSECTION 9: UNDERGROUND STORAGE

The following provisions shall apply to all underground liquid hazardous material storage systems.

SUBSECTION 9.1

Owners shall file with the Board of Health the size, type, age(if known), and location of each tank, and the type of hazardous materials stored in each, on or before September 1, 1983.

SUBSECTION 9.2

Owners of tanks for which evidence of installation is not available shall, at the order of the Board of Health, have such tanks tested. If either the Board of Health or the Head of the Fire Department determines that the tank is not product tight

SUBSECTION 9: CONTINUED

it shall be repaired or disposed of under the direction of the Board of Health or the Head of the Fire Department.

SUBSECTION 9.3

All tanks shall be tested the day of installation and thereafter at intervals sufficient to prevent loss of hazardous materials and resulting contamination.

SUBSECTION 9.4

All newly installed tanks subject to this By-law shall be protected from internal and external corrosion and shall be of a design approved by the Board of Health and the Head of the Fire Department.

SUBSECTION 9.5

All leaking tanks must be emptied by the owner or operator within twelve hours of leak detection; and repaired to a product tight condition or removed by the owner or operator in a time period to be determined by the Board of Health.

SUBSECTION 10: EFFECTIVE DATE

All storage provisions contained in Subsections 7, 8 and 9 must be complied with by July 1, 1984.

SUBSECTION 11: REPORTING REQUIREMENTS

Any person having knowledge of a reportable discharge of hazardous material shall immediately report the discharge to the Board of Health, and if involving falmmable or explosive materials, to the Head of the Fire Department.

SUBSECTION 12: PROTECTION OF PUBLIC WATER SUPPLIES

In order to protect and preserve existing drinking water sources, the following uses are prohibited within one thousand (1,000) feet of the head of a gravel packed well used as a source of municipal drinking water unless exempted by a variance in accordance with Subsection 14 of this By-Law.

SUBSECTION 12: CONTINUED

A. Automotive service and repair shops, junk and salvage yards, and car washes.

B. Storage of road salts or other deicing chemicals

C. Use of chemicals for deicing unless deemed necessary for public safety.

D. The discharge of hazardous materials.

E. Commercial or industrial uses which require registration in accordance with Subsection 6 of this By-Law.

F. Commercial or industrial uses which discharge process wastewaters on-site, excluding discharges permitted in accordance with all applicable State and Federal regulations which are shown to contain no contaminants.

G. Commercial or industrial uses which re-charge stormwater to groundwater without passage through oil and grease traps and sediment traps, constructed, operated, and maintained to minimize groundwater contamination.

SUBSECTION 13: PERMITS REQUIRED

A. A permit shall be required and obtained from the Board of Health for all new commercial or industrial establishments requiring registration in accordance with Subsection 6.2, prior to the operation of said establishment, to determine that the provisions of this By-Law have been met.

B. A permit shall also be required and obtained from the Board of Health for all establishments requiring registration in accordance with Subsection 6, who seek to install additional aboveground or underground hazardous materials storage tanks.

SUBSECTION 14: VARIANCES

The Board of Health may vary the application of any provision of this By-Law, unless otherwise required by law, in any case when, in its opinion, the applicant has demonstrated that an equivalent degree of environmental protection required under this By-Law will still be achieved. The applicant at his own expense must notify all abutters by certified mail at least ten days before the Board of Health meeting at which the variance request will be considered. The notification shall state the variance sought and the reasons thereof. Any variance granted by the Board of Health shall be in writing. Any denial of a variance shall also be in writing and shall contain a brief statement

EARTH REMOVAL BYLAW AMENDMENT

Excavation shall be restricted to those areas which are at elevations ten feet or more above the maximum groundwater elevation as determined by the most recent testing conducted under the provisions of this section.

No permit shall be issued or renewed under this Bylaw until the applicant has submitted to the Board current and complete information on the actual and proposed depth of excavation and the maximum groundwater elevation throughout the entire area proposed to be excavated. Maximum groundwater elevation shall be determined by means of monitoring wells, test pits and soil borings during the months of March, April or May. Such tests shall be conducted by a Massachusetts Registered Professional Engineer at the expense of the applicant and shall be observed by a representative of the Board. Test results shall be submitted to the Board over the engineer's stamp.

The groundwater monitoring wells shall be left in place during the period that the applicant holds a permit hereunder, and readings therefrom shall be taken during March, April or May of each year. The results of such readings shall be submitted to the Board over the engineer's stamp.

APPENDIX D
Funding and Technical Assistance Sources

There are a number of programs administered by state agencies under the Executive Office of Environmental Affairs that provide support for water supply protection measures. Technical assistance is available as well as grant monies allocated for land acquisition programs and technical services. Below is a brief summary of some of these programs, including a contact for further information.

* DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Household Hazardous Wastes Collection

The Department of Environmental Management's Office of Safe Waste Management can assist communities with education about household hazardous wastes and suggest alternative products to decrease the amount of hazardous wastes being used and ultimately disposed of by households. DEM staff can also help organize local collection and disposal efforts. Under Chapter 584, section 47, matching grant funds were made available in FY'87 and FY'88 through the Office of Safe Waste Management for collection, transportation and disposal of household hazardous wastes. More than 100 communities have held collections to date. Funds for future grants are pending.

Contact: Cassandra Goldwater
DEM, Office of Safe Waste Management
100 Cambridge Street, Boston, MA 02202
727-3260

* DEPARTMENT OF ENVIRONMENTAL QUALITY ENGINEERING, DIVISION OF WATER SUPPLY

Aquifer Land Acquisition

The Aquifer Land Acquisition Program (ALA) provides financial assistance to communities to purchase land or easements to protect the recharge areas of water supply wells and/or surface drinking water supplies. A 20% match is required from grantees. In order to be eligible for funds, communities must have delineated Zones I, II and III around their water supply wells. Purchase of lands in the Zone II area are eligible for reimbursement under ALA if all other criteria of the program are met. Applications receiving the most favorable review are from communities who have already demonstrated a commitment to water supply protection through land holdings that protect water supply, land uses compatible with water protection, and land use controls such as water supply overlay protection districts or related restrictive zoning. ALA funds may be used to finance further studies of Zone II (approximately 10% of grant award) and to acquire land in fee by outright purchase, or to acquire future development rights of land through the use of conservation restrictions.

Contact: Mike Stroman, Aquifer Land Acquisition Program Manager
DEQE, Division of Water Supply
One Winter Street, Boston, MA 02108
292-5526

Groundwater Technical Assistance

The Groundwater Technical Assistance Program within the Division of Water Supply is set up to offer a variety of technical, planning and educational programs to enable communities to increase their knowledge and protection of water supplies. There are five main programs available.

1. Technical Assistance. Includes technical review of groundwater studies and reports, advice on development and implementation of groundwater protection bylaws and regulations.

2. Water Supply Protection Atlas. Provides statewide environmental data in the form of transparent overlays for USGS quadrangles. This enables communities to associate water supplies with geologic information and possible sources of contamination.

3. Local Bylaws and Regulations File. Provides a summary of existing and proposed bylaws and regulations by community and some model bylaws for review and comparison.

4. Groundwater Slide Tape Programs. DEQE has slide-tape programs about groundwater movement, contamination, and protection techniques, and underground storage concerns.

5. publications. General groundwater information is available in a bimonthly newsletter and the agency also has a series of handbooks discussing various aspects of groundwater and groundwater protection.

Contact: Mike Rapacz
DEQE, Division of Water Supply
One Winter Street, Boston, MA 02108
292-5952

Leak Detection and System Rehabilitation

This program provides financial assistance to public water suppliers to conduct water audit projects and leak detection surveys, and for rehabilitation and replacement work on existing water distribution systems. Such work may include: cleaning and lining or replacing water mains, replacing appurtenances, system looping, or covering finished water storage tanks when ordered by DEQE or DPH. Grants are awarded for projects conducted on publicly owned water systems on a 50% reimbursement basis. Any public entity that owns and operates a public water supply system is eligible.

Contact: Jack Hamm, Program Director, Construction Grants Program
DEQE, Division of Water Supply
One Winter Street, Boston, MA 02108
556-1080

Meter Modernization

This program provides financial assistance for replacement work or rehabilitation work on the public water metering system. Such work may include new meter installation, modernization, rehabilitation, or centralized utility metering. Grants are awarded for projects conducted on publicly owned water systems on a 50% reimbursement basis. Any public entity that owns and operates a public water supply system is eligible.

Contact: Jack Hamm, Program Director, Construction Grants Program
DEQE, Division of Water Supply
One Winter Street, Boston, MA 02108
556-1080

Water Filtration

This program provides financial assistance for the construction of drinking water filtration facilities. Grants are awarded for projects conducted on publicly owned water systems on a 50% reimbursement basis. Any public entity that owns and operates a public water supply system is eligible.

Contact: Jack Hamm, Program Director, Construction Grants Program
DEQE, Division of Water Supply
One Winter Street, Boston, MA 02108
556-1080

DIVISION OF WATER POLLUTION CONTROL

Construction Grants

This program provides financial assistance for the design and construction of wastewater treatment facilities. Project costs are shared with 35% from federal funding, 55% from state funding, and 10% from local funding.

Contact: Paul Taurasi
DEQE, Division of Water Pollution Control
One Winter Street, Boston, MA 02108
292-5739

Tier II Construction Grants

This program provides state funding for 70% of construction costs for communities with projects that did not rank high enough to receive federal wastewater treatment plant funding.

Contact: Allen Slater
DEQE, Division of Water Pollution Control
One Winter Street, Boston, MA 02108
292-5749

Collection Sewers

This program provides financial assistance for the construction of new collection sewers. Grants fund up tp 50% of eligible construction costs to a maximum of $3 million.

Contact: Leo Andronico
DEQE, Division of Water Pollution Control
One Winter Street, Boston, MA 02108
292-5681

Infiltration and Inflow

This program provides financial assistance to correct problems of infiltration and inflow (I/I). Grant awards cover up to 90% of the cost of conducting an I/I source study and the construction work to upgrade the water supply system. Infiltration occurs when clean water leaks into sewerage systems through defective pipes and connections. Inflow occurs when clean water enters the sewerage system via storm drain interconnections or illegal sump pumps or downspout connections from private homes. Reducing I/I will reduce the unnecessary flow of clean water to wastewater treatment plants.

Contact: Jim Courchaine
DEQE, Division of Water Pollution Control
One Winter Street, Boston, MA 02108
292-5728

DIVISION OF SOLID WASTE

Landfill Capping Grants

This program provides financial assistance to municipalities for the closure of municipal landfills in an environmentally sound manner.

Contact: Larry Galkowski
DEQE, Division of Solid Waste
One Winter Street, Boston, MA 02108
292-5973

Comprehensive Landfill Assessment and Clean Up Program

This is a new program funded through the new Solid Waste Act. One hundred million dollars has been appropriated to study the approximately 700 active and inactive landfill sites in the Commonwealth for possible groundwater contamination. These sites will qualify under the Solid Waste Act (Chapter 584) for funding to conduct hydrogeological and remedial action feasibility studies. Grant awards provide 90% of the project costs, supplemented by a 10% loan to the grantee.

Contact: Joseph Selle
dEQE, Division of Solid Waste
One Winter Street, Boston, MA 02108
292-5970

* DIVISION OF CONSERVATION SERVICES

Self-Help

This program provides grants to municipalities for land acquisition to preserve open space for conservation and passive recreation. State funding is available to cover between 63-90% of the land costs, based on a municipality's per capita equivalent. Eligibility requirements include an established conservation commission and an approved open space/conservation and/or recreation plan.

Contact: Joel Lerner
Division of conservation Services
100 Cambridge Street, 20th fl., Boston, MA 02202
727-1552

APPENDIX E

NORTH SHORE WATER SUPPLY PROTECTION ADVISORY COMMITTEE

Memorandum of Understanding

WHEREAS the Towns of Essex, Hamilton, Manchester, and Wenham and the City of Beverly in Essex County, Massachusetts have certain natural resources of surface and underground waters, streams, water courses, and watersheds within the common areas of the five communities; and within the several communities are located certain ponds, lakes, reservoirs, storage basins and wells now used or with a potential use as sources of water supply, and

WHEREAS the communities have a common interest in protecting such natural resources to ensure the availability of water in such quality and quantity as necessary to meet the present and future needs of the inhabitants of the communities,

NOW, THEREFORE, the signatories of this memorandum of understanding representing the communities agree as follows:

1. To consult together, cooperate and act jointly in matters pertaining to natural resources of wetlands, surface and underground waters within the boundaries of the communities.

2. To consult together and make recommendations relative to zoning and general by-laws which may affect such resources, adopted by the communities under their independent home rule authority.

3. To consult together and make recommendations relative to the adoption and promulgation of rules and regulations of the several city and town boards whose official duties concern the use of land, the protection of natural resources, and the present and potential sources of water supply.

4. To work together as a mechanism for joint local action for the resolution of water quality and water resource issues.

It is further agreed that it is the intent of this memorandum of understanding that local action and implementation of local powers shall be utilized to the fullest extent. For the purpose of providing public information and advice on matters pertaining to the protection of water resources, this association of signatories may be referred to as the Water Supply Protection Advisory Committee. The membership of the committee shall be comprised of one representative and one alternate from each participating community, to be certified in writing by the respective appointing authorities. Each community may determine its own procedures for appointment. The committee shall function as an advisory committee to the Chief Elected Officials of each community, and shall report its findings and recommendations to the participating communities.

It is further agreed that this memorandum may be amended from time to time by agreement of the signatories. Such amendment may provide for participation by representatives of other adjacent municipalities.

Dated:

For the City of Beverly
Mayor ______________________________

For the Town of Essex
Board of Selectmen ______________________________

For the Town of Hamilton
Board of Selectmen ______________________________

For the Town of Manchester
Board of Selectmen ______________________________

For the Town of Wenham
Board of Selectmen ______________________________

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Superfund Amendment & Reauthorization Act	40 CFR Amendments to CERCLA
Resource Conservation & Recovery Act	40 CFR Part 261
Federal Safe Drinking Water Act	40 CFR Part 141-149

CODE OF MASSACHUSETTS REGULATIONS

Right to Know Regulations	310 CMR 33.00
Employers Hazardous Substances Disclosure	105 CMR 670.00
Pesticides Control Act	333 CMR 11.00
Groundwater Quality Standards	314 CMR 6.00
Surface Water Quality Standards	314 CMR 4.00
Safe Drinking Water Act	310 CMR 22.00
Hazardous Waste Management Act	310 CMR 30.00
Landfill Regulations	310 CMR 19.00
Groundwater Discharge Regulations	314 CMR 5.00
Wetlands Protection Act	310 CMR 10.00
State Environmental Code, Title 5	310 CMR 15.00
Fire Prevention Regulations/Underground Storage Tanks	527 CMR 9.00
Fire Prevention Regulations/Abandoned Tanks	527 CMR 10.12(2)